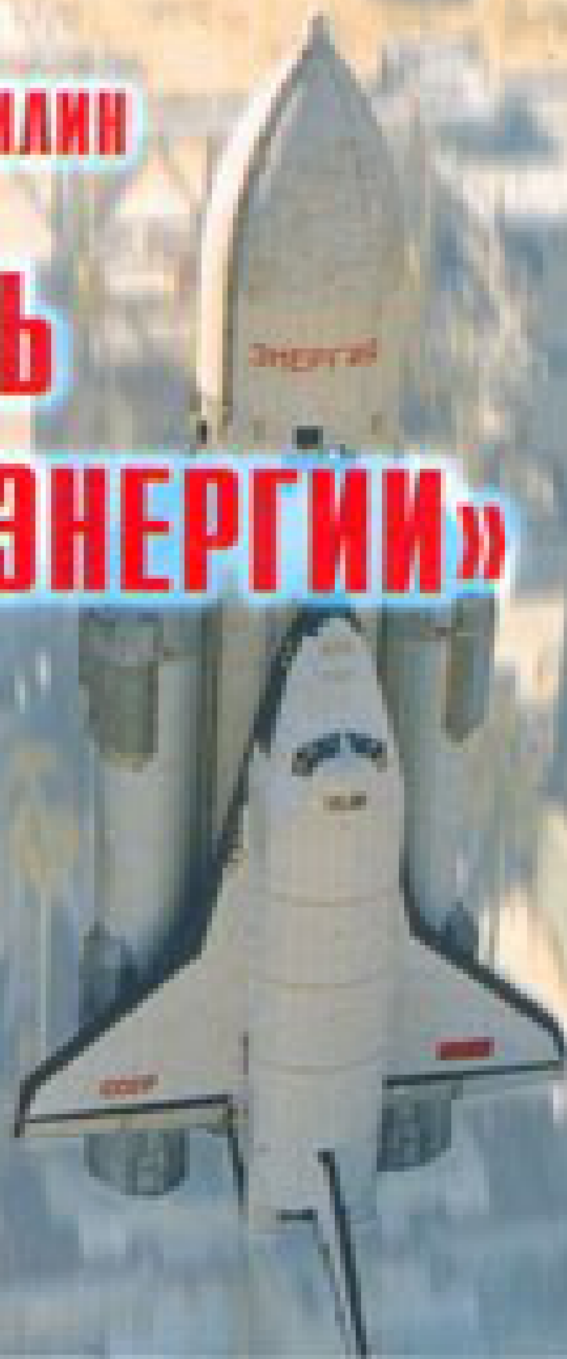


В.М.Филин

ПУТЬ

К «ЭНЕРГИИ»



Annotation

The “Energia” launch vehicle is an outstanding creation of domestic scientists, designers, and testers, unsurpassed to this day. It is capable of delivering up to 100 tons of large-sized cargo into Earth’s orbit. V.M. Filin, Deputy General Director of the Energia Rocket and Space Corporation, tells about all stages of the rocket’s creation, about the people involved, and about the atmosphere of creative passion in which they worked. He supports his memoirs with unique photographs.

For a wide range of readers.

2001

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The Path to “Energia”

INSTEAD OF AN INTRODUCTION

Baikonur.... Once, this word attracted the whole world. A mysterious, fantastic cosmodrome somewhere in Kazakhstan, which millions dreamed of visiting. This word, first heard on April 12, 1961, when the radio announced the flight of the first man into space, immediately became close and desired, becoming the pride of our science and engineering thought. It is difficult now to imagine the enthusiasm and emotional uplift that reigned that spring in the capital and other cities, when excited people took to the streets and moved in long columns to the central squares. The words “Gagarin — cosmodrome” became inseparable. Everyone wanted to visit this fabulous place in Kazakhstan, if only for a minute. Everyone had their own ideas about it, but they all boiled down to the fact that something very significant and grand was being done there. We, students of the Moscow Aviation Institute, practically the first graduates in rocket specialization, were especially impatient. We were ready to fly to this Baikonur tomorrow and see with our own eyes everything we had been taught. At that time, we did not imagine all the hardships and difficulties that the pioneers experienced on this land. We learned about this later, already working at enterprises.

We eagerly listened to the stories of “experienced” people about the cosmodrome, about the sleepless nights of the testers, about funny everyday stories somehow related to alcohol, about fishing on rare weekends, about the severity of the Chief Designer, and much, much more. Some cursed these places, but as soon as a tiny opportunity for a trip appeared, their faces transformed, becoming mysterious. They proudly looked at those remaining in the design bureau and disappeared for a certain time. And after another TASS report, they returned to the design halls and, with childlike impatience, awaited inquiries about the next launch. Special boasting, if one can say so, was evident in stories about military orders, about their personal ability to get along with test officers, and about numerous co-contractors. But not once did I hear from them about the weather or the charm of this region.

Much later, when years had already connected me with this cosmodrome, I began to wonder why, after returning from a most difficult business trip from the testing ground (as Baikonur was called at our enterprise), literally a week or two later, an unknown force again pulls you back. Why don't you remember the exhausting heat, when the temperature in the shade is over 40°; nor the dust

storms, when sand crunches on your teeth and it seems that your lungs and stomach are full of it; nor the piercing frosty wind, in which, despite all your clothes, you feel as if you are naked on the street on a winter day.

All this recedes into the background. What remains is the incomparable spectacle of a rocket launch. What remains is the feeling of a person who has harnessed this incredible energy, and your heart aches when you see your object disappear into the unknown, and even if you never meet it again, it is precisely it that will reveal some part of the secrets of space. Touching something significant makes you one of those initiated into a certain mystery, but this is purely professional. And the sunrise, like the sunset, captivates forever, and not only the testers, but everyone who has visited the steppes of Kazakhstan. The abundance of color schemes in the sky so clearly reveals the heavenly colors that the brightest rainbow pales before these phenomena. And the sunset! Even if you glance at it by chance, you won't be able to tear yourself away until it melts into the approaching night. And as it departs, it will embrace the horizon like a crimson crown and fade, leaving bright diamonds in the black sky. And they, as if taking over the baton of beauty, begin to glow stronger and stronger and, finally, paint the entire bottomless sky with the pattern of their intricate figures.

As if a carpet were hung,
Woven by a magical hand.
A pattern scattered like beads.
And all this — for you and me!

A. Koreshkov

And these endless steppe expanses, where you feel free and your thoughts are carried away into the distance! Was it not here that the projects of “Vostoks” and “Voskhods” were born?

But this land is especially charming in spring, when bright tulips emerge into the light, breaking through the elastic layers of alumina. They cover the earth, awakening from winter, with a yellow-red carpet. The air is of extraordinary purity, because the wind has not yet left its dust particles in it. You breathe sweetly and deeply. And with what disgust you wait for the smells of a passing car to dissipate. After all, you can suffocate from its gases here, and only then do you understand what people in cities are used to. You can walk for hours across the steppe and admire the awakening life. You look at a tulip flower, emerging to the surface before your eyes, and you marvel at the power of life. After all, this tulip shows itself to people for only two weeks a year: “Look, here I am! My life is short, but I give all my beauty to you, people. Pause for a minute, think about the meaning of life. Your life is not so long, enjoy it.”

The approaching heat and bright sun will drive it back into the ground, and it patiently waits all 350 days to make itself known again.

When you fly over the endless Kazakh expanses and look down, it seems as if you are rushing over some unknown planet, cold and lifeless. But then the plane lands, and the first thing that greets you in summer is truly a Finnish sauna. You immediately find yourself in these 44°C, although for the first few minutes after the plane, you don't understand why everyone is dressed so lightly. Upon reaching the waiting car, you can no longer bear it and slowly begin to take off your jacket, tie, roll up your sleeves, and only movement saves you from heatstroke. Due to the very low humidity, the emerging drops of sweat immediately disappear in the wind, which at least somewhat improves your well-being.

You look around and realize that this steppe is not so lifeless. You often encounter jerboas, who look at you with naive curiosity and wonder: why did you come to their domain? Can you endure it here? Will you disturb their peace? Their cute little heads turn to follow you, and the black embers of the animals' eyes remain with you for a long time.

The testing ground.... Here, on this limited piece of Kazakh steppes, everything merged into one, all joys and problems. Like oases in the desert, green areas are scattered throughout its territory. For us, people from the middle latitudes, it becomes clear here what water means for this land. You understand and remember for life that water is life, and if it weren't for the daily and painstaking work of people, there would be no these green islands in the steppe. There would be no city on the banks of the Syr Darya, a city where mainly military testers live and which has sheltered "industrialists" — as civilians, representatives of dozens of design bureaus, research institutes, and factories are called here — in its comfortable homes. And the city was founded in an absolutely deserted place, and the first military builders, led by General Shubnikov, erected residential buildings in parallel with the launch facilities. Builders laid dozens of kilometers of concrete roads, and following them, water pipelines and power lines stretched along these routes to the sites where rockets and spacecraft are prepared for launch. What happiness it was when water flowed from the taps in the living rooms! Only it gave life to the karagach trees and poplars planted near hotels and facilities by kind hands, and turned these sandy places into oases.



The city of Leninsk. Garrison House of Officers

One of them at the cosmodrome is Site 2, known throughout the world. After all, it was here that S.P. Korolev's "household" was located. Here is his house, and here is the house where Yu.A. Gagarin and G.S. Titov spent their last night before the launch. Here are also the hotels of NPO "Energia," where I had to live for several years when we moved to the final stages of creating the "Energia—Buran" system. We will return to the story of the testing ground, but I want to dwell on one of the last epochal events in the history of the Soviet Union — the creation of the "Energia" launch vehicle.

I took up my pen and became scared: how to cover everything without offending the participants — after all, there are about a million of them, and I want to apologize in advance to everyone I do not mention in my narrative and whose work brought about our victory.

I want to believe that among these millions, there will still be people who will write their memoirs about the history of the creation of this system. Each person's thoughts are subjective, and only a generalization of various memoirs and publications can help readers form an objective picture.

A BIT OF HISTORY

Any product, in an engineer's terms, begins with an axial line. So where to begin the story of creating a colossal rocket and space system? With the work of GIRD or GDL? Or with September 9, 1944, when Germany began the combat use of the V-2 (A-4) rocket? Or with March 5, 1946, when Churchill announced in Fulton the program of Anglo-American world domination, which led to an unprecedented arms race among countries with different systems? And Churchill knew well about Hitler's rocket weapon, which was supposed to turn the tide of the war. He also knew that the Americans had already rushed to Germany to find both this weapon and those who were involved in it.



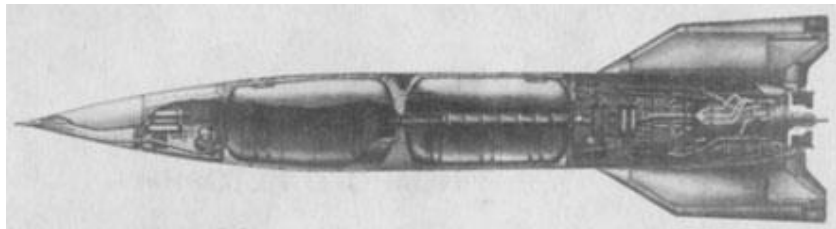
Sergei Pavlovich Korolev

Already in May 1946, one hundred rockets and the dismantled largest plant in Peenemünde were exported from Germany to the USA. The best German specialists, led by Wernher von Braun, also went overseas, which allowed the Americans to begin testing a prototype of the V-2 rocket as early as April 1946.

And what about our country?! By Resolution of the Council of Ministers of the USSR dated May 13, 1946, No. 1017-419, a number of research institutes, design organizations, and factories were organized, headed by State Union Research Institute No. 88, whose task was to create long-range missiles. The Soviet government set them the task of creating a missile no worse than the V-2 (A-4).

For this purpose, two series of rockets, ten copies in each series, were prepared: series T, assembled in the USSR from parts

brought from Germany, and series N, equipped with rockets assembled in Germany. The first fire test of a series T rocket on the stand of the state central proving ground was conducted on October 17, 1947, at 0 hours 30 minutes.



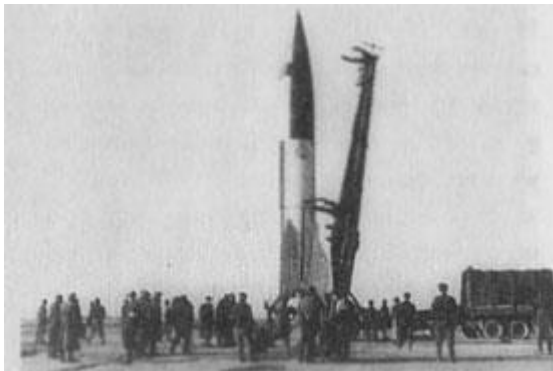
Layout of the R-1 rocket

The first of these rockets lifted off from the proving ground on October 18, 1947, at 10 hours 47 minutes. Only five rockets successfully flew their two hundred-plus kilometers.

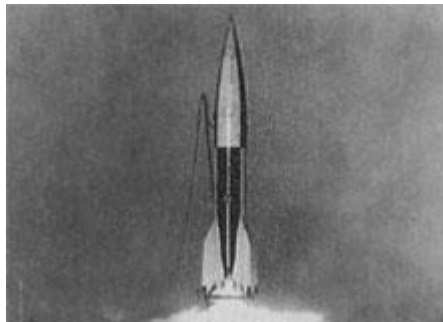
At the same time, department No. 3 of NII-88, headed by the Chief Designer of Product 1 (as the domestic long-range ballistic missile was called), tried to create the domestic R-1 missile, the tactical and technical requirements for which were developed by the Main Artillery Directorate of the Ministry of Defense. The first launch of the R-1 took place on September 17, 1948. Due to abnormal operation of the control system, the rocket deviated by 51° and flew 10 km. Only the fourth launch, conducted on October 10, 1948, at 16 hours 52 minutes, was successful.



R-1 rocket on the launch pad



Preparation of the R-1 rocket for launch



Launch of R-1 rocket engines

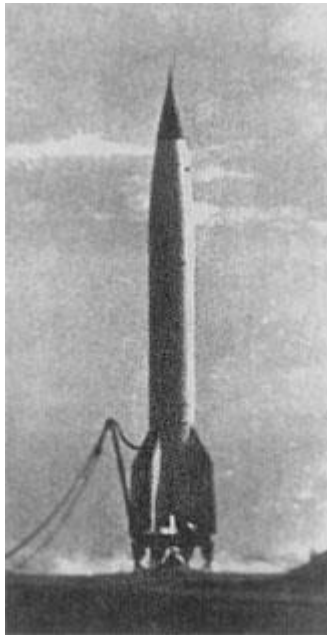
Thirteen research institutes and design bureaus, as well as thirty-five factories, participated in the creation of the R-1.

Thus, two years later, our country also acquired its own long-range combat ballistic missile.

It should be recalled that by this time both the USA and the USSR already possessed atomic weapons. The military formulated their concepts for conducting nuclear war. The USA already had a widely branched network of military bases. American magazines published maps showing targets for priority air strikes on Russia. The Cold War was escalating. The intensifying confrontation between the two systems led to the creation of military blocs in 1949, in particular the North Atlantic bloc, which included the USA, Great Britain, France, Italy, Canada, Belgium, the Netherlands, Portugal, Denmark, Norway, Iceland, and Luxembourg.



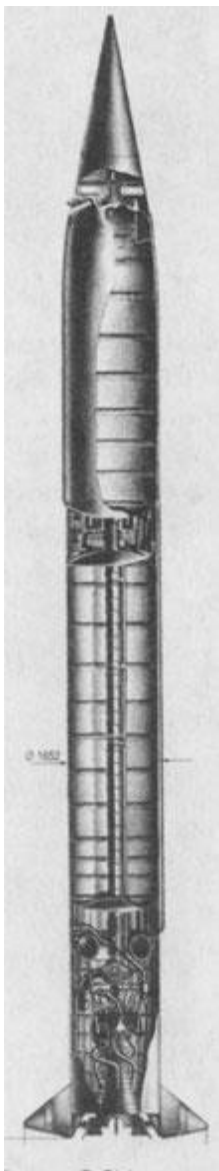
R-2 missile system



Launch of the R-2 rocket engine

Flight design tests of the R-1 rocket were completed in 1949, and on November 25, 1950, the rocket was adopted by the Soviet Army. A year later, on November 27, 1951, the R-2 rocket was also adopted by the army, essentially built on the basis of the R-1, but

with an increased flight range of up to 600 km and a separable warhead. Veterans with whom I managed to talk about that period recall that these rockets had very good fuel: its remnants in the refueling hoses were divided equally among everyone. This fuel was the purest rectified alcohol.



R-5M rocket — the first rocket capable of carrying a nuclear warhead

The few German specialists who left for home predicted that reliable ballistic missiles meeting the necessary range and accuracy requirements would not appear in our country anytime soon.

Meanwhile, at NII-88, OKB-1 was formed on the basis of

department No. 3, headed by S.P. Korolev. OKB-1 continued the development of the single-stage R-3 rocket, which began in 1948. In December 1949, at a meeting of the NTS NII-88, the preliminary design of the single-stage R-3 rocket with a firing range of up to 3 thousand km and a warhead mass of up to 1 ton was defended. At that time, this was a fantastic range, which they decided to master in stages, starting with a calculated range of 900 km. But the R-3 rocket was not destined to be created, as a range of only 1200 km was achieved instead of 3000. The new rocket was assigned the index R-5. In 1952, design and engineering developments were completed, as well as the necessary calculations for ballistics, strength, controllability, and aerodynamics.

The R-5 rocket had load-bearing tanks and a separable warhead. The first launch took place on March 15, 1953, and on February 2, 1956, an R-5M rocket with a nuclear warhead was launched.

The Soviet government's announcement on August 20, 1953, about the testing of a hydrogen bomb in the USSR shocked many. After all, thermonuclear weapons had been created, with an explosive force hundreds and thousands of times greater than atomic bombs. The superpowers now had the ability to instantly destroy millions of people, to wipe entire countries off the face of the Earth. Means were needed to deliver such a bomb to any point on the globe. Given the vulnerability of aviation, the Council of Ministers of the USSR, by resolution, entrusted NII-88 with the task of developing a rocket project in 1953-1954 capable of delivering a 3-ton payload over a distance of 8-10 thousand km. The creation of super-powerful thermonuclear weapons and such a rocket, in the opinion of the Government, could deter aggression against our country, no matter where it came from. After all, a retaliatory strike would be inevitable.

Nuclear charges were still far from perfect, and therefore it was necessary to increase the useful payload of the rocket from 3 tons to 6. Oh, how S.P. Korolev would later use this! But let's try to proceed in order.

Our country was surrounded by dozens of military bases, the Cold War was escalating, and only such a rocket with a nuclear charge could sober up the politicians in the West.

In our design bureau, it was said that the tactical and technical assignment for creating such a rocket was approved by I.V. Stalin himself. But I have not seen such a document and therefore cannot assert this with certainty, although it is reliably known that I.V. Stalin received S.P. Korolev.



Installation of the R-5M rocket on the launch pad



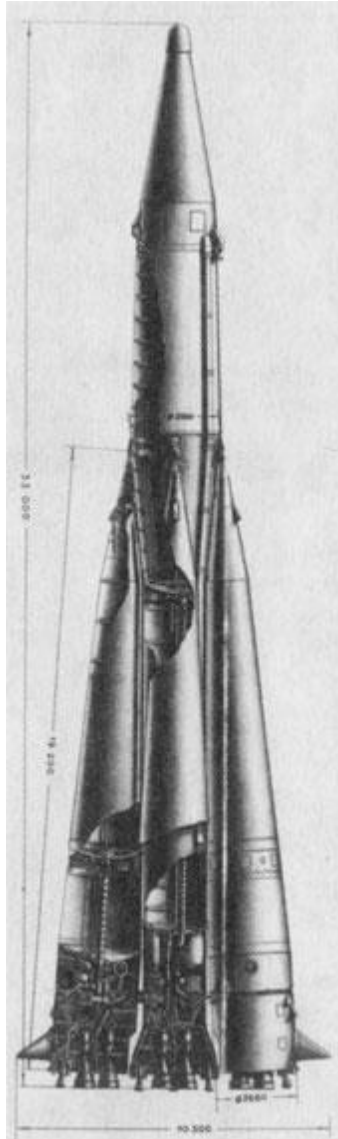
Launch of the R-5M rocket engine

Having such an important task, NII-88 reorganized its forces. The institute was relieved of cruise missile topics, and S.P. Korolev was appointed Deputy Director for experimental design and research work.

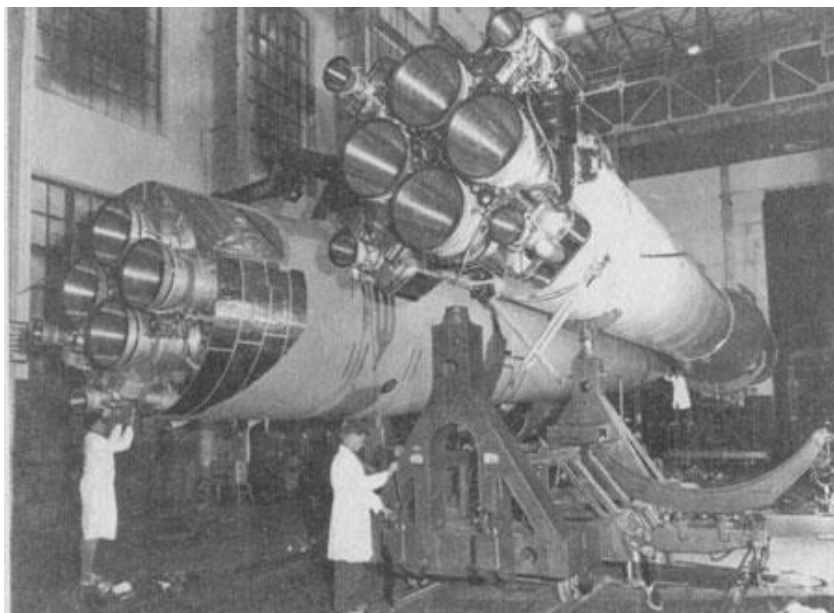
In mid-1954, the preliminary design of the new rocket was developed and approved by the state commission. The search for the rocket's appearance is well shown in the film "Taming the Fire" by director D.Y. Khrabrovitsky. One only needs to imagine for a moment that time, when the country had just healed the bleeding wounds of war, when our industry began to gain production momentum, when agriculture became capable of leading the country out of hunger. And it was then that the task was set to create a flying device unique for its time. It was necessary to

prepare the production and experimental base, conduct research on a wide range of problems, find their solutions, and confirm them on experimental products.

To achieve the specified requirements for payload mass and range, the rocket must have high characteristics, for which new structural materials and new technologies should be used. And the achievement of high characteristics depended on various industries: metallurgy, chemistry, machine tool building, etc.



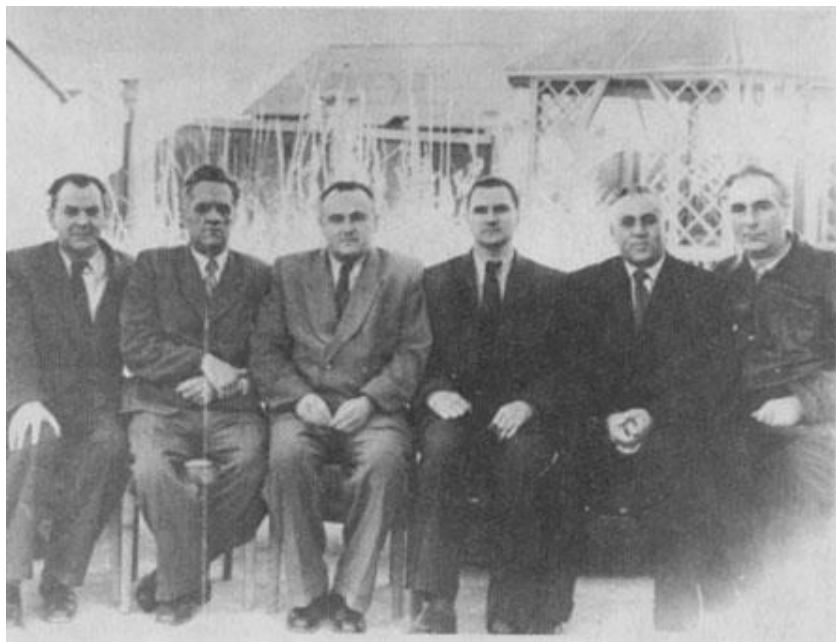
Intercontinental R-7 rocket



Assembly and functional testing of the R-7 rocket systems were first carried out in a stationary assembly and test facility. Four-chamber main engines and steering engines are visible on the blocks (four-chamber on the central block, two-chamber on the side block)

In parallel with the rocket, engine development began at OKB-456, where V.P. Glushko was the chief designer. Instead of alcohol, which had proven itself well in all respects, aviation kerosene of brand T-1 was adopted as fuel. Although this saddened the testers, kerosene turned out to be much more effective for the product, as it surpassed alcohol in energy output by 25%. The specific impulse of engines using it and the oxidizer — liquid oxygen — reached 310 s in vacuum. Four-chamber RD-107 and RD-108 engines with thrusts of 85-100 and 75-95 tf, respectively, were developed for the central and side blocks.

The development of the control system was entrusted to NII-885, headed by chief designer N.A. Pilyugin. The co-executor of the control system was V.I. Kuznetsov, developer of gyroscopic systems. M.S. Ryazansky was responsible for the radio control systems of the rocket. And the last “pillar” on which the development rested was the launch complex. Its development was led by V.P. Barmin.



Council of Chief Designers: M.S. Ryazansky, N.A. Pilyugin, S.P. Korolev, V.P. Glushko, V.P. Barmin, V.I. Kuznetsov

This is how the famous six was formed, united in the Council of Chief Designers headed by S.P. Korolev: V.P. Glushko, N.A. Pilyugin, V.P. Barmin, M.S. Ryazansky, V.I. Kuznetsov. This team of like-minded people, ensuring the organization of development, resolved all fundamental and current issues. And the decisions of the Council of Chiefs were law for all developers.

Much has already been written about the history of the legendary R-7. The entire path of the genesis of rocket technology is particularly detailed by B.E. Chertok in the book "Rockets and People." Today, the R-7 rocket is often shown on television. Having undergone a series of modernizations, it launches various satellites into orbit, cosmonauts fly on it, and for thirty-five years it has been in service with our space forces. It has made about two thousand flights, and each time one watches its mesmerizing launch with admiration.

And back then, it was just beginning. In addition to the rocket, a new proving ground (the future cosmodrome) also needed to be built. In the winter of 1954, a State Commission arrived in Kazakhstan. Choosing a site for the proving ground proved difficult. The commission traveled thousands of kilometers in the area of Tyura-Tam station. It was necessary to investigate the flight path, select uninhabited areas where spent first stages would fall, and at the same time maintain secrecy. The proving ground had to be supplied with electricity and water — therefore, there had to be a

good river and a state power line nearby. The location near Tyura-Tam turned out to be suitable, and in the spring of 1955, the first landing party of military builders landed on the banks of the Syr Darya, and the construction of the city, which later received the name “Leninsk,” began.

In September 1956 (!) builders began installing equipment for the launch complex. The top of a small hill was chosen as the launch site. The builders dug a gas deflector trench 30 m deep. The hill was built up with the excavated soil, and an access road was planned. (The height of the launch pad was calculated so that the rocket on the pad would not be visible from trains passing on the railway line.)

In early 1957, the final stage of ground testing was completed. Fire tests of the rocket were conducted on a special stand at NII-229 (Sergiev Posad). The next stage was flight tests. The center of excitement and anxiety shifted to Tyura-Tam.

The first launch of the R-7 rocket took place on May 15, 1957. Let's remember this date. The flight was interrupted by a fire in the tail compartment of the side block.

The second launch on June 9, 1957, did not take place: the rocket was removed from the launch pad. The third launch on July 12, 1957, was again an accident due to the control system. On August 21, 1957, the rocket flew. It fully completed the entire flight program. On August 27, 1957, a TASS report stated: “A few days ago, a super-long-range, intercontinental, multi-stage ballistic missile was launched. The missile tests were successful; they fully confirmed the correctness of the calculations and the chosen design. The missile's flight occurred at a very high, previously unattained altitude. After covering a huge distance in a short time, the missile hit the designated area.



R-7 rocket before its first launch

The results obtained show that it is possible to launch missiles to any region of the globe. Solving the problem of creating

intercontinental ballistic missiles will allow reaching remote areas without resorting to strategic aviation, which is currently vulnerable to modern air defense systems.

Considering the enormous contribution to the development of science and the great importance of this scientific and technical achievement for strengthening the defense capability of the Soviet state, the Soviet government expressed gratitude to the large team of workers who participated in the development and manufacture of intercontinental ballistic missiles and the complex of means ensuring their launch.”

Thus, what is now considered an outdated product, not optimal in certain parameters, announced to the world that our country had an intercontinental missile. The atmosphere of the Cold War reached its climax, but the missile’s flight sobered many and gave a small impetus to a thaw. And the narrator in the film “To Which Stars We Fly” rightly said: “Look closely at this rocket; it saved us from a nuclear catastrophe, stopped the war that was at our very doorstep.”

Our country, our people, once again, made themselves respected, and their inexhaustible capabilities were taken into account.

But the mind of Chief Designer S.P. Korolev was occupied not only with defense tasks. Knowing the capabilities of the rocket well, he raised the question of creating an artificial Earth satellite. I learned from his associates that, after writing a brief justification, S.P. Korolev visited the main institutes of the USSR Academy of Sciences, and not a single academician saw prospects in creating a satellite; everyone turned away from this project. The pressure and will of S.P. Korolev and M.V. Keldysh did their job. The simplest satellite was launched into orbit on October 4, 1957, and again a TASS message:

“The successful launch of the first man-made Earth satellite makes a major contribution to the treasury of world science and culture. The scientific experiment carried out at such a great height is of immense importance for understanding the properties of outer space and studying Earth as a planet of our Solar System.

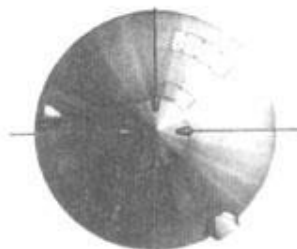
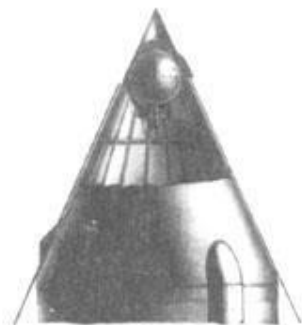
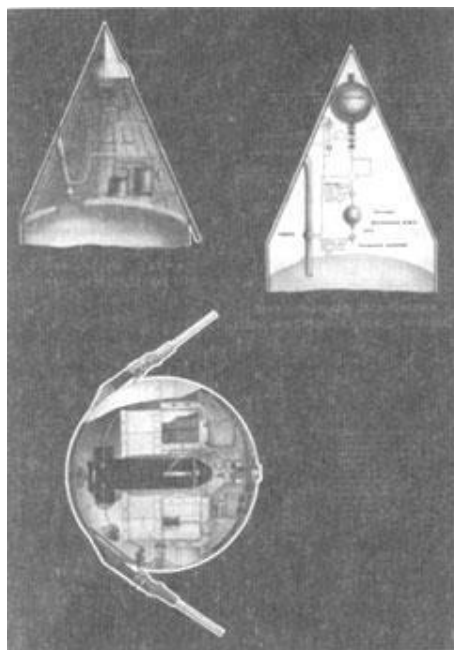


Diagram of the installation of the first artificial Earth satellite on the rocket and its pneumohydraulic separation scheme.
Placement of the first artificial satellite under the fairing

During the International Geophysical Year, the Soviet Union intends to launch several more artificial Earth satellites. These subsequent satellites will have increased dimensions and weight, and a broad program of scientific research will be carried out on them.

Artificial Earth satellites will pave the way for interplanetary travel and, apparently, our contemporaries are destined to witness how the liberated and conscious labor of people of a new, socialist society makes the most daring dreams of humanity a reality.”

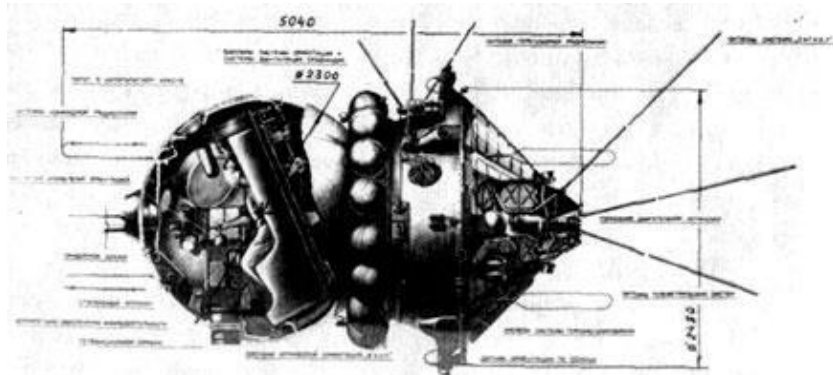
The Russian word “sputnik” became known throughout the world, not satellite, but SPUTNIK!

At the request of nuclear scientists, the rocket’s payload was increased to 6 tons, which allowed us to significantly outpace Western countries in delivering cargo to orbit. After all, their rockets were designed for loads of 1-1.5 tons. S.P. Korolev could not fail to use such an advantage. He began designing a spacecraft. What words: “spacecraft”! Today it’s common: spacecraft, space station... But back then, it was hard to believe that in 3-4 years people would witness the birth of a new industry and new thinking. At the OKB-1 enterprise, the ship was simply called “Object 3KA.” Only after the flight was this object called “Vostok.” Many technical problems had to be solved, and solved for the first time. These tasks primarily involved protecting humans from environmental

influences: vacuum, thermal effects during descent, vibration, overloads during takeoff and landing, and the effects of Earth's radiation belts, which had only recently been discovered. It was necessary to create at least elementary living conditions for the pilot, to think through everything, right down to the toilet. On Earth, we sometimes don't even notice these daily needs, but here it's weightlessness!

They worked with enthusiasm, evenings, weekends. This was a time when such an uplift reigned at the enterprise that it seemed man would reach the Moon and Mars literally tomorrow.

For all earthlings, like a bolt from the blue, came the voice of Levitan, announcing on the radio the launch of the first man into space. The first human flight aboard a modernized R-7 rocket ("Vostok") with a Block E rocket as the third stage. Our advantage in payload mass came in handy. The rocket began to work not only for defense but also for science, and how! Each new launch was a TASS report: reached the Moon, flew to Mars or Venus, launched the Molniya communication satellite, the Electron-1 and Electron-2 scientific stations, etc. This was conversion! And what a conversion!



Vostok spacecraft (3KA)

Everyone immediately understood that space was not a show; it was communication, television, reconnaissance, science, new technologies, and materials. Our country became a trendsetter in the field of space. And every Soviet citizen was proud of this.

Every country has its achievements. In England — the first steam locomotive and steamboat, in America — the telephone, airplane, etc. And for us — space. We were so proud of our successes that we didn't even notice how the USA began to catch up with us and already in 1961 announced its national goal — to be the first to land a man on the Moon. It was our turn to strive not to fall behind.

The author does not aim to follow the chronology of rocket technology development. After all, in addition to OKB-1, in the late

50s, SKBs were created in Dnepropetrovsk, Miass, and Moscow, which developed both tactical and strategic missiles for defense needs. They formed the so-called rocket and nuclear shield of the Motherland. We, however, want to trace the history of only heavy-class rockets. This will help determine the groundwork our country had before the creation of the “Energia” rocket.

The next stage after the R-7 was the development of the UR-500 rocket (“Proton” in the press) at the OKB headed by V.N. Chelomey. During its first flight on July 16, 1965, it launched the “Proton-1” satellite, weighing 12.2 tons, into orbit. This rocket, like the R-7, is still in service. After modernization, it launched the “Salyut” and “Mir” stations and their modules into space; only it, equipped with a space booster block developed in the early 70s by our team, launches communication satellites into geostationary orbit. During its existence, this rocket has confirmed its high reliability characteristics.

In June 1960, S.P. Korolev, together with the chief designers of the systems, appealed to the government with a proposal to create a powerful launch vehicle weighing 1000-2000 tons for launching a heavy spacecraft weighing up to 60-80 tons into Earth orbit. At that time, it seemed that such a mass was sufficient for an expedition to fly around Mars. The proposal was accepted and the procedure for creating the N1 launch vehicle was established, including conducting flight design tests in 1960-1963. The same Government Resolution provided for the development of a preliminary design for an expedition to the Moon in the second quarter of 1961, and for expeditions to Mars and Venus in the second quarter of 1962. This is how we approached the creation of the Soviet Lunar manned program.

LUNAR PROGRAM

On May 25, 1961, US President J. Kennedy announced the start of development of a space system to land a human on the Moon. This national task was intended to raise the prestige of the USA on the world stage. In May of the same year, while intense work was underway on the preliminary design of a super-heavy rocket, a Resolution of the Soviet Government suspended the creation of spacecraft for the exploration of the Moon, Mars, and Venus. All attention of design bureaus and industry was focused on tasks related to the country's defense. The deadline for creating the super-heavy H1 launch vehicle was postponed to 1965.

The year 1961 was long remembered not for the monetary reform, but for the extreme exacerbation of the Cold War. It was in this year that the direct communication line between the Kremlin and the White House became red-hot. As a result of the Cuban Missile Crisis, the world stood on the brink of a real nuclear war.

Defending the project for creating heavy rockets, S.P. Korolev sent his deputy V.P. Mishin to the State Committee for Defense Technology to prove that these vehicles could also solve military tasks. Only they could ensure the creation of a comprehensive space defense system for the country. This system was to include means for detecting and warning of missile and space object launches; spacecraft capable of hitting attacking missiles taking off from any point on Earth; and missiles in constant combat readiness, capable of delivering a warhead to any point on Earth in any direction within minutes.

At that time, the state of rocket and space technology provided grounds to assert the reality of creating such a system. The country's industry was already capable of building large-mass spacecraft. The advantages of rockets launching such vehicles also included high economic efficiency. The H1 rocket in this strategy was assigned the role of a carrier of warheads capable of hitting the entire territory of the enemy.

Preliminary calculations showed that to launch a spacecraft capable of destroying enemy missiles in flight, a three-stage rocket with a launch mass of approximately 2000 tons was required. The creation of H1 was proposed to be divided into two stages. The first stage involved clearly formulating the requirements for the second and third stages and, on this basis, building an independent rocket with a launch mass of about 750 tons (2.5 times the mass of the R-7), capable of putting a 25-ton satellite into Earth orbit.

The second stage was to involve the creation of the actual three-stage H1 rocket with a launch mass of 2500 tons. Such a sequence could reduce the cost and accelerate the development of the H1 rocket, as by the start of flight tests, the control system and upper stages of the most labor-intensive and expensive first stage would already be ready.

Now, it is impossible not to mention the rocket engines. Much has been said in the press about the dispute between S.P. Korolev and V.P. Glushko. By this time, V.P. Glushko's company, which developed all main engines (first and second stages) for all space rockets, having accumulated vast experience, believed that it had the right to choose fuel components for the engine of such a rocket. In the USA, for the designed F-1 engine of the Saturn-V rocket with a thrust of 680 tf, liquid oxygen and kerosene were planned to be combined. In contrast, V.P. Glushko proposed installing an engine with a thrust of 600 tf on the H1 launch vehicle, using unsymmetrical dimethylhydrazine and nitrogen tetroxide as fuel. By their properties, long-storing components were good for combat missile systems, but in terms of toxicity, they surpassed the chemical warfare agents of World War I. The implementation of the project would have raised the prestige of V.P. Glushko's company. But S.P. Korolev, understanding all the dangers of producing such fuel and the consequences (God forbid!) of careless handling during operation, began to insist on changing this pair of components to a "dietary" one: oxygen-kerosene. After unsuccessful persuasion, S.P. Korolev was forced to turn to N.D. Kuznetsov with a request to develop engines for H1. And although N.D. Kuznetsov's company was known in the aviation world, their experience in rocket engine building and test stand facilities was insufficient. As a result, S.P. Korolev and N.D. Kuznetsov settled on an engine thrust of 150 tf. Thus, twenty-four NK-15 engines appeared on the first stage, and eight on the second. Four of N.D. Kuznetsov's engines were also installed on the third stage.

But with the persistence characteristic only of V.P. Glushko, his company began developing a 600 tf thrust engine. Residents of Khimki and the Khimki-Khovrino district of Moscow observed huge reddish clouds appearing over the test stands. At that time, people did not particularly question the impact of such industrial emissions on humans, and only in secret reports was it mentioned that the toxic properties of these products do not disappear over time, but, once in a person's blood, say, through the lungs, accumulate until misfortune occurs. S.P. Korolev knew this well. That is why, as they say, he stood his ground "to the death."

In June 1962, the preliminary design of the H1 was reviewed

by the State Expert Commission, which confirmed the correctness of the choice and the principal layout of the elements and fuel components. The commission noted the reality of creating a rocket capable of launching 75 tons into Earth orbit within the planned timeframe: 1962-1965. According to the commission's conclusion, the H1 rocket complex could solve not only military-strategic tasks but also scientific ones, since the preliminary design materials considered options for spacecraft allowing for a lunar flyby, a flight to Mars and Venus with a crew of two or three people, and even the creation of research bases on the Moon and the nearest planets of the Solar System. The prospect of further improving the launch vehicle by using hydrogen fuel, which the Americans had been working on for years, considering it essential for their Lunar project, was also shown.

Military departments, including the Main Missile and Artillery Directorate of the USSR Ministry of Defense, reacted cautiously to the project, noting in their conclusion in November of the same year that the issues of military use of the rocket were superficially elaborated. At the same time, in November, a new Government Resolution was issued, which, wishing to maintain the leading position of the Soviet Union in space exploration, accepted the proposal of the H1 launch vehicle developers to accelerate work precisely on this launch vehicle, omitting the stage of creating the two-stage H11 rocket.

The rocket's characteristics were also approved. For flight design tests, which were expected to begin in 1965, eight to ten rockets were planned for production. The methodology for developing a super-powerful rocket remained the same as for conventional rockets, although its launch mass, I remind you, was 2200 tons! And this indicates that quantity transforms into quality, because each product of such a mass becomes unique for the industry.

The three-stage H1 rocket had transverse stage separation, a height of over 100 m (like the Monument to the Conquerors of Space on Mira Avenue in Moscow), and a base diameter of 17 m. Spherical fuel tanks for each stage (blocks A, B, C) were suspended on thermal bridges.



H1 launch vehicle on a transport-erector in the assembly and test building of the cosmodrome

From today's perspective, it is clear that a significant air volume of the rocket was underutilized, especially compared to the American version. But everything had its explanation. Let's remember that time. After all, the industry as a whole had not yet fully recovered from the war, and the scientific and technological revolution that could have influenced the rocket's design had not yet arrived.

And at that time, the main criterion for choosing the shape of fuel tanks was the requirements of electric welding. They still couldn't weld rocket materials thicker than 20 mm. So the designers looked for tank configurations where the strength thickness would be minimal. And for that, there's nothing better than a sphere. That's how spherical tanks appeared on the rocket. But the "spheres" were the size of a four-story building: on the first stage, about 13 m in diameter for the oxidizer and 10 m for the fuel.

Yes, the dimensions of the rocket turned out to be truly enormous. The question of its delivery to the test site immediately arose. There was even a project by the design bureau of the I.A. Likhachev plant to create a transport unit with a lifting capacity of 70 tons, which would transport the rocket across the steppe (1000 km) from the city of Guryev to the cosmodrome. And to Guryev, the rocket was delivered from the Samara manufacturing plant "Progress" by a self-propelled barge. But Guryev was not destined to become a transshipment base. The first calculations showed that it was more economically feasible to build an industrial and

construction base directly at the cosmodrome and carry out the assembly of individual tanks, blocks, and the rocket as a whole on site. And in 1963, by decision of the Ministry of Special Assembly and Construction and the Ministry of Defense, construction of an industrial base began at the cosmodrome. Within two years, assembly and test buildings (MIKs) were erected in the steppe, and next to them, a residential town for workers and engineers.

For such a gigantic rocket, a special launch complex was needed, the development of which was entrusted to one of the great “six” — V.P. Barmin, who headed the GSKB. By the end of 1963, this organization, along with its subcontractors, completed the project. According to it, the rocket was laid horizontally on a specially created transport-erector unit and, with the help of two synchronized diesel locomotive couplings, moved to the launch position along a truly “golden” road, so much concrete was invested in it, because God forbid the rocket should fall!



Cosmodrome. On the steps: G.A. Tyulin, N.I. Krylov, S.P. Korolev, B.A. Stroganov
(first row), V.P. Barmin, M.S. Ryazansky, N.A. Pilyugin, A.G. Mrykin, V.I. Kuznetsov

(second row), N.V. Pavelyev, A.G. Zakharov, A.G. Iosifyan

The program for using the rocket was envisioned as grandiose, so with one technological complex providing rocket fueling, thermostatic control, and system management, two launch pads

were built. It sounds modest: two launch pads. But these were colossal structures! Suffice it to say that the depth of the gas ducts was 21 m, and the rocket service tower rose to 130 m. I believe its creators will still write about the launch complex and its originality.

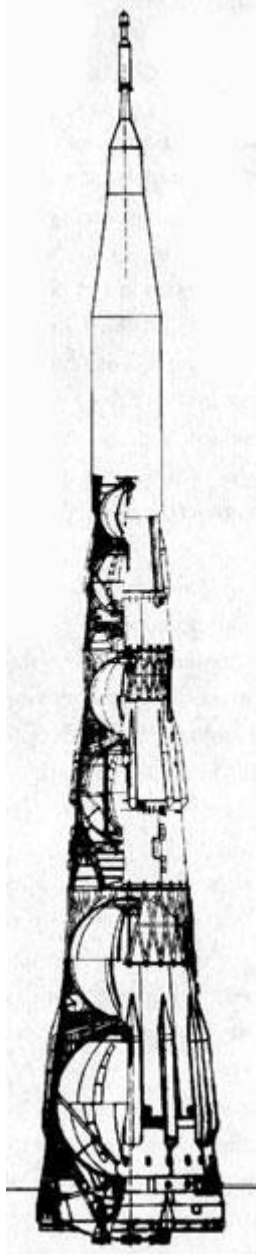
The gigantic fuel reserves of the rocket also required gigantic storage facilities, as 1800 tons of liquid oxygen alone had to be supplied to the rocket. A very complex task. A special association “Kriogenmash” was organized on the basis of the Balashikha plant, and it was entrusted with the creation of fueling equipment.

As a result, the launch complex combined 36 ground facilities, 80 sets of ground-based and technical equipment.

Tens of thousands of people, hundreds of enterprises joined the work on the new rocket. The government created a coordinating scientific and technical council headed by S.A. Zverev, which included S.P. Korolev as deputy for technology, M.V. Keldysh for science, and G.A. Tyulin for coordination. Subsequently, the chairman of the council became the Minister of General Machine Building of the USSR, S.A. Afanasyev.

The Americans were also successfully moving forward with their program. Saturn-1B had already made its flights, flight tests of Saturn-V had begun, and work was underway on the Apollo orbital spacecraft and the lunar module. Even the tragedy of January 27, 1967, when three American astronauts burned to death in the Apollo cabin in a few seconds during ground tests, only slightly slowed down their plans.

Considering the achievements of our “friends,” on August 3, 1964, the Government, by its Resolution, outlined plans for the coming years, giving paramount importance to lunar research and the development of work on the study of outer space and the planets of the Solar System. But first and foremost, the Soviet man must step on the Moon by the 50th anniversary of the Great October Socialist Revolution! What a task: the Moon is ours in three years. There was even a song about Vasya, who would be the first on the Moon.



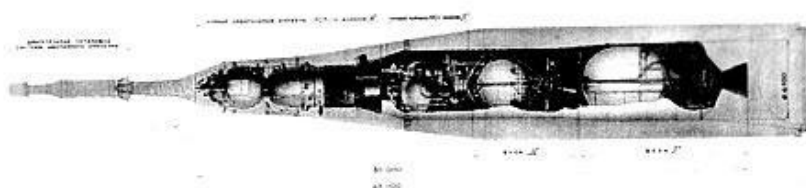
The N1-L3 rocket and space complex was created for the Lunar manned program

It was planned to explore the Moon in two stages. The first was a flyby by cosmonauts, who would be delivered to the Moon by the existing Proton launch vehicle of V.N. Chelomey. And the second stage was the delivery of an expedition to the lunar surface by the H1 rocket and its return to Earth. S.P. Korolev was designated as the chief designer of the second stage of the project.

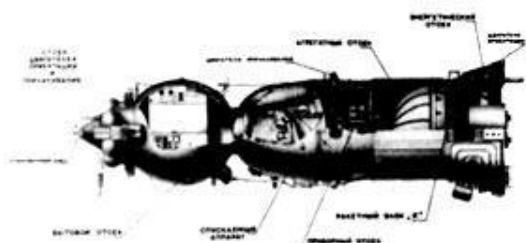
The program for cosmonauts to fly around the Moon was named L-1. The spacecraft for such an expedition was developed by S.P. Korolev's company. The first unmanned Zond spacecraft had already been launched, with which entry into Earth's atmosphere at second cosmic velocity was practiced and unique images of the Moon and Earth were obtained, but the cosmonauts never made it. The main reasons were the high-boiling fuel components, their toxicity, and the insufficient reliability of the rocket itself.

The second stage program for delivering an expedition to the Moon was designated N1-L3. To tell about it, let's return to the super-rocket H1, which, as already mentioned, consisted of three stages. But to accelerate the Lunar complex towards the Moon, block G was needed. After completing its work, block G separated, and the next block D took over, ensuring further flight to the Moon and entry into orbit around it for two manned vehicles: the Lunar Orbital Ship and the Lunar Ship.

The expedition crew consisted of two cosmonauts, and their main dwelling was the orbital spacecraft. During the flight in orbit around the Moon, one of the cosmonauts transferred through open space to the Lunar spacecraft, which, together with block D, delivered this brave man from lunar orbit to its surface. After a short stay on the Moon, the ascent stage delivered him back to lunar orbit, where his expedition colleague awaited him in the orbital spacecraft. They docked and returned to Earth in the same Lunar Orbital Ship. This is how the expedition scheme was briefly presented. The author described the scheme and lunar spacecraft in more detail in the book "Memories of the Lunar Ship" in 1992.

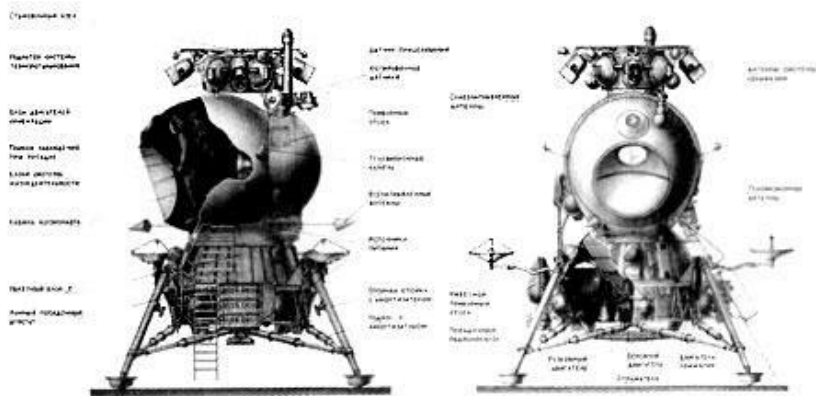


Lunar rocket complex L3



Lunar Orbital Ship (LOS)

ОСНОВНЫЕ ХАРАКТЕРИСТИКИ	
• ЧИСЛО ЧЕЛОВЕК	2 ЧЕЛОВЕКА
• МАКСИМАЛЬНАЯ ДЛИНА ПОЛЕТА	13 СУТОК
• ВЕС КОМПЛЕКСА НА ВыхОДЕ НСА	8850 кг
• ВЕС КОМПЛЕКСА ПРИ ВХОДЕ В ЗЕМЛЕ	7530 кг
• ВЕС СПУСКОЧНОГО АППАРАТА	2804 кг
• ХАРАКТЕРИСТИКИ БЛОКА „Н“	
• МАКСИМАЛЬНЫЙ ДИАМЕТР (ДИНАМИЧЕСКИЙ)	3388 мм
• ТИГА	314 м/с
• СКОРОСТЬ - КОМПЕНСИРОВАННЫЙ ДИАМЕТР	
• ТИГА	417 мм
• ДИАМЕТР ТИГА	298 мм
• ЗАПАС ГОРЮЧЕВА:	
• ДОПОЛНИТЕЛЬНЫЙ (ПОДВИЖНЫЙ)	2032 кг
• ДОПОЛНИТЕЛЬНЫЙ (ПОДВИЖНЫЙ)	1120 кг
• ГАБАРИТЫ:	
• ДЛИНА	10080 мм
• МАКСИМАЛЬНЫЙ ДИАМЕТР КОМПЛЕКСА	2930 мм



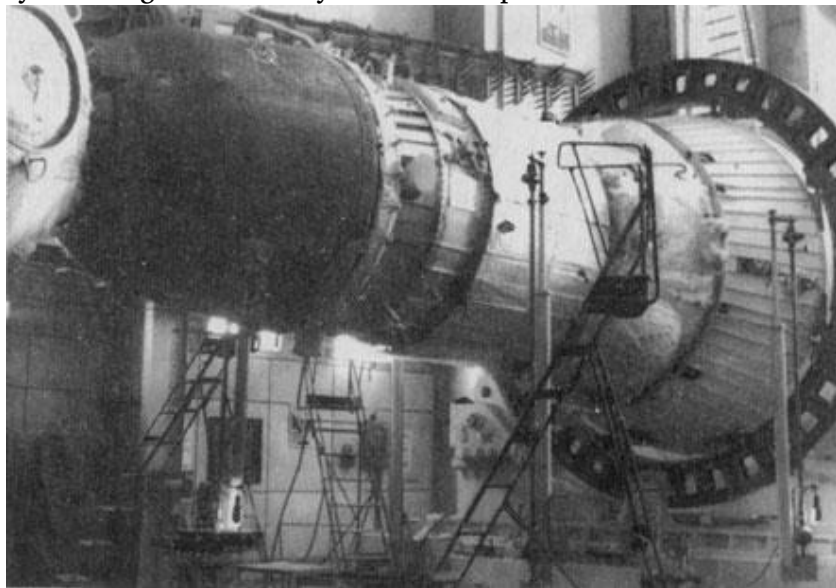
Lunar Lander (LL)

As we can see, only two cosmonauts were tasked with fulfilling the Soviet national objective, not three, as in the USA. But even for two cosmonauts, there was a terrible lack of energy, or simply put, mass, or, as they said then, weight. The question arose that the rocket had to lift a head unit weighing about 100 tons into low Earth orbit for the entire program to “tie together.” This circumstance required the installation of an additional 6 engines in the central part of the first stage. I believe that there will still be developers who will write about the problems that had to be solved when creating the H1 launch vehicle. I can only say with confidence that there were many: with strength, with controllability, with engines, with instrumentation, with gas dynamics, etc.

The year 1966 arrived. Sad news shook us. It was hard to believe that S.P. (S.P. Korolev) was no longer with us. Vostok and Voskhod flights were still ongoing, but he was already fully immersed in the Lunar project. And now S.P., for whom the H1 project became the main one in his life, was gone. Thousands upon thousands of people came to the Hall of Columns of the House of Unions to bid farewell to S.P. Korolev. And he was only sixty years old! A man of rare talent, fantastic scientific foresight, he became known to the country as the founder of Soviet practical cosmonautics. OKB-1 fell silent for a time, awaiting a new leader. S.P. Korolev's associates appealed to the party and country leadership with a request to appoint V.P. Mishin to this position. Their request was granted. Work on the creation of H1 continued at the same pace, although several stages of experimental tests were reduced. And now, it seems, everything is behind us. Is it all? After all, they were constantly pushed and pushed “from above.” It's easy to reason now that the engines had not yet been developed to the required reliability, that they had not passed fire stand tests, that

the engines were installed on rockets without preliminary fire checks, that only one from a batch was tested, and so on. It's easy to talk now, we all become smart afterwards. But for such decisions, to meet deadlines and the wishes of the "higher-ups," a theoretical basis is provided by the designers themselves. Thus, the authors of the invention certificate for a method of testing one engine from a batch, which would drastically reduce time and money, were chief designers V.P. Mishin and N.D. Kuznetsov.

In December 1968, F. Borman and his colleagues D. Lovell and W. Anders flew to the Moon. They entered a selenocentric orbit and, after making ten orbits, returned to Earth. Meanwhile, we were only finishing the assembly of the first operational rocket.



Lunar Orbital Ship on a transport-erector



N1-L3 complex en route to the launch pad



N1-L3 complex near the launch device

Finally, the rocket is assembled. It lies in the MIK (Assembly and Test Building) and awaits the decision of the State Commission — to fly or not. The chairman of the commission, S.A. Afanasyev, interrogates everyone meticulously and persistently about readiness. But the mood of all those gathered was one: to fly faster. Only flight will answer the question of whether the rocket exists or not, only during flight will the final comprehensive tests of all

systems be carried out. Everyone wanted one thing: to fly as soon as possible. Here she is, the beauty, tested on Earth, waiting for her hour. And indeed, she is beautiful. The swiftness of forms, the simplicity of lines, unusual stabilizers, unobtrusive fairings, delicate connecting trusses — everything speaks of the completeness of these simple structural fragments. The commission gives permission (what else could it do?).

And then — launch. On February 21, 1969, everyone froze, both at the test site and in the design bureau. A live report from the cosmodrome came over the loudspeaker. Liftoff! It's going! How slowly these seconds pass: 20, 30, 50 and... silence. What happened? The rocket stopped its flight. Official conclusion: fire in the tail section of the first stage. This happened at the 55th second of flight. Silence fell in the design halls. In the design bureau and at the test site, people tried not to look at each other, as if everyone understood that the accident could have happened due to their fault. Everyone was hurting. But gradually the shock passed. It was necessary to act. They remembered that the first R-7 flight was also unsuccessful, and began to think about how to refine the rocket. A little time passed, and this almost minute-long flight was already evaluated as productive. Yes, it gave a lot. As a rule, the first rockets are equipped with additional instruments that monitor the operation of all units.

Rocket production was developing faster than the embodiment of designers' ideas in metal.

July 1969 arrived. A new rocket was ready. We so wanted at least the first stage to work. Technical management, the State Commission, and the rocket on the launch pad. Again, agonizing minutes before launch. Intense work by ground crews. It's no joke: about 2.5 thousand tons of fuel had to be poured into the rocket. That's eight trainloads!

The launch date for the American expedition to the lunar surface was already known. Would we even manage to launch mock-ups of the Lunar ships?! The intense day of preparation turned into evening, evening into night, it was already July 3, and a bright glow colored the sky. A night launch — that is the most memorable and impressive spectacle.

But what is this?! The rocket somehow slowly rises above the deflectors (lightning rods), fades, and then settles back onto the launch pad. An explosion!!! And of such force that individual parts of the rocket were found several kilometers away. All windows and doors in the residential town were blown out, and the engineering buildings loomed with empty openings. It's no joke, it was like (in equivalent recalculation) 500 tons of trinitrotoluene exploded. They

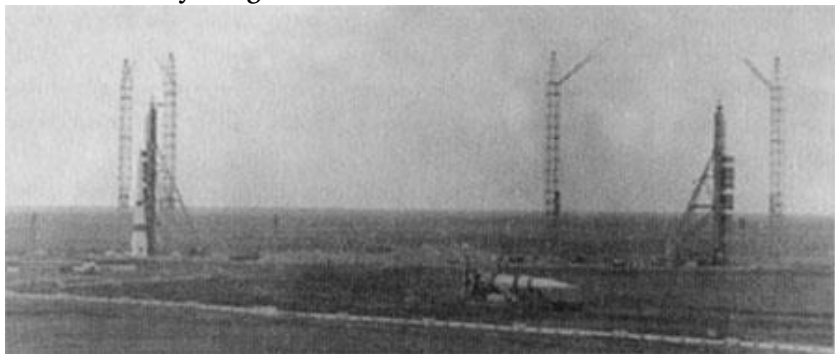
say that Vasily Pavlovich Mishin walked around repeating only three words: “How could this happen?! How could this happen?!”

For many years, one of the huge spherical tanks of this rocket lay on the very edge of the roof of the large assembly and test building (or simply “large MIK”), as if reminding of what had happened.

And what happened was this. Upon reaching the main stage operating mode, engine #8 failed, and, as the telemetry data decryption showed, the temperature around engines #7, 8, and 9 sharply increased. The special engine control system, acting according to its programmed logic, immediately shut down the opposing engines. At the 10th second, an electrical circuit malfunction occurred, and at the 11th, all engines except one shut down. At the 23rd second, the rocket fell onto the launch pad.

All direct participants, according to their accounts, were absolutely certain that the engines were not yet ready for flight and that the question of their refinement needed to be raised, which meant taking responsibility for missing deadlines. That was the main issue! V.P. Mishin and a delegation went to N.D. Kuznetsov. But after a one-on-one conversation, the reason began to be “covered up.” And the soft character of the Chief Designer of the rocket was to blame for everything; his technical arguments were shattered by a prepared report to the Government about his personal behavior in everyday life, since the Chief’s fondness for Russian feasts was no longer a secret to anyone.

The launch complex presented a grim picture. Everything was twisted, wrenched, broken, burned. The launch pad required restoration. This required funds. So much effort had been invested in each structure, in each system of the complex, and then in seconds — everything was out of order.



Second N1-L3 complex en route to the launch device



H1-L3 complex installed on the launch device

A new rocket is being prepared in the MIK. Hundreds of thousands of hands are working on the product, and when it explodes before your eyes, there's no room for delight or pride. What courage the employees of the Progress plant must have had, seeing their product in fragments, a product that took many, many months of intense mental and physical labor, wasted nerves, and strained relationships due to arguments about how to do it better and faster. And now, cursed fractions of a second carry all of this into the utter darkness of history. And how to go into the workshops with a cheerful mood and again make components and assemblies, carry out assembly, see a new product being born, but with only one thought: will it fly?! Is everything thought through, are we working in vain? It must be said that even after such a tragic launch, everyone believed in success.

Meanwhile, colleagues across the ocean had already sent their expedition complex to the Moon. Literally three weeks after the second launch, specifically at 2:56 AM Greenwich Mean Time on July 21, 1969, US citizen Neil Armstrong stepped onto the Moon! Television companies around the world showed the American flag on the Moon. And although, as engineers, we marveled at this colossal technical achievement, it felt like cats were scratching at our souls. All the sleepless nights, working without days off, the enormous emotional tension for the sake of the USSR being first on the Moon — all in vain. Now only one thing remains — not to fall completely behind. This became our stimulus.

The launch pad was destroyed, the assembly machine stalled. It was necessary to deal with the engines. Again, endless commissions,

events, tests.

Time rushes faster than desired. A year and a half passed. Relatively good engine test results were obtained. Assembly could be completed. The tulip spring quickly flashed by, and summer took over, the hottest time at the cosmodrome — late June. At this time, in 1971, the third rocket went to the launch pad, but not to the left one, like the first two, but to the right. Both launch pads are visible in the photograph. Restoring the left launch pad in those two years was beyond the power of even military builders and installers from Minmontazhspetsstroy. Therefore, it was decided to accelerate work on the right launch pad. Initially, we said that the service systems were unified for both launches, and the provided protection for technological and technical systems largely ensured their preservation. The correctly shaped mounds, faced with reinforced concrete slabs, inside which the systems were located, are clearly visible. They withstood all the loads during the explosion.

The rocket is on the launch pad. Again, these seemingly endless tests, from checking individual units to playing through all flight operations. Technical director B.A. Dorofeev, as they say, pokes into every “hole”: what if something is wrong, what if...

State Commission. S.A. Afanasyev again extracts conclusions from everyone, without any “ifs” or “however.” His questions made everyone present feel somewhat uneasy. The report of Chief Designer V.P. Mishin. Summarizing the speeches, he gives his approval for the launch. The minutes drag on agonizingly, and finally, the decision is made. The launch is scheduled for June 27.

Launch! 5 seconds, 10, all engines are finally working! But what is this?! The machine slowly spins around its axis. The roll misalignment continuously increases. The steering nozzles have already hit their stops, unable to cope with the disturbances. At the 48th second, the rocket and space complex began to disintegrate. At the 51st second, the flight was aborted by an emergency command.

What is this? Just bad luck or a technical flaw? To this, I can confidently say that luck only happens when the equipment is designed and manufactured taking into account all possible operating conditions, tested and verified for these conditions. Then luck comes. And here — the third launch and again bad luck? That doesn't happen. This means we still haven't learned everything that can stop the flight of such a huge machine. So, the third launch. The spinning of the product. Later, the accident commission's report would state: “...The most probable cause of the accident was the combined action of disturbing moments, not previously identified or accounted for when selecting the available roll control moments.”

The machine needed to be “cured.” By this time, the engine for

block D of this complex, with a thrust of 8 tf, had been sufficiently tested. The modified chambers from these engines were then installed on the periphery of block A, so that the combined disturbing moments were no longer a threat. The product was modified quite quickly, and five months later (such pace would be unthinkable now), the rocket was back on the launch pad.

And again, the technical leadership carefully reviewed all innovations and their development. The chief designer was hospitalized, and the fourth rocket was launched by his deputy, B.E. Chertok, on whose shoulders lay enormous responsibility. Somewhere subconsciously, everyone felt that this launch might be the last.

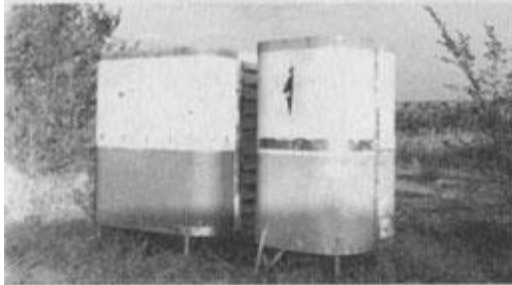
And the chairman of the State Commission, S.A. Afanasyev, again began to extract every last bit from everyone: "Have you thought carefully, have you weighed everything, maybe postpone the launch, is there something else that needs to be checked?" And he frankly scared, no, not scared, but rather seriously warned that this launch would be the last. Everyone stood for carrying out the launch. What was it: from hopelessness or from confidence?! It's hard to talk about it now. Rather, both. As the Russian saying goes: either a chest full of medals, or a head in the bushes.

November 23, 1972 — the date of the fourth rocket launch. The flight lasted 106.93 seconds. And again, the engine failed. The first stage of the rocket never worked completely. "Just a little bit left," V.P. Mishin later said. That "little bit" was missing. Again, they rushed to find the reasons. The design bureau was in a fever. New testing schemes were invented, they proposed returning to the N11 launch vehicle scheme, to work on it first. But all this already resembled an agony.

From the very beginning, the entire lunar complex was "tied" with a large mass deficit. The rocket had not yet "learned to fly," but measures to increase its capabilities were already in full swing. They even began to consider options for two-launch schemes: for example, the first launch would send an upper stage to the Moon, and the second — manned spacecraft. But in those days, orbital docking was a rather complex undertaking, there were many failures; therefore, even a direct scheme was considered, where a heavy-protected descent vehicle was delivered to the lunar surface and then launched directly back to Earth. There were many schemes, but the main thing was missing — the rocket did not fly.

The engines never achieved sufficient reliability; moreover, they abandoned the hot-fire stand testing of the first stage — it was too expensive; they had not yet completed the entire complex of ground tests, but four launch attempts had already been made.

Hence the failures, but this is technical, and on top of that, there was pressure from above. After all, cosmonautics in the USSR at that time had firmly become political!



Use of H1 rocket structural elements for household needs at the cosmodrome

Now many believe that the fifth flight would have been successful. God be their judge! The flight would have been

successful — that's for sure, but, I think, with such an approach to technology and such a sweatshop system — not the fifth, but the ...th. But this is the author's subjective opinion.

Now, looking back and remembering those times, it's hard to say what would have happened if IT had flown. After all, there were practically no programs for its use other than the Lunar one. And what was frightening was not that the H1 wouldn't fly, but that it COULD FLY, and then it would be discovered that "the emperor has no clothes." Our industry was not yet ready for such grandiose projects, it's no joke to say, a 100-ton spacecraft. It alone would require at least 70 tons of equipment, and that's the entire annual, or perhaps monthly, output of our electronic industry. So, for this, should other industries be halted: communications, television, radar, and so on?! Later (twenty years later) we felt this keenly. When the successful launches of the Energia rocket stumped everyone.

The triumph of the American Lunar program was somewhat smoothed out when, on September 12, 1970, lunar soil (not kilograms, but grams) was delivered by Luna-16 to the territory of the USSR. It began to be explained to ordinary people that this was our Soviet path in cosmonautics. It was oriented towards automatic research, which was capable of solving practically all scientific tasks.

But the television interview with cosmonaut A.A. Leonov, who commented on this event, was also remembered: "Everything is grandiose, but how much I want to land on the Moon myself! After all, no automaton can compare with a human." That says it all.

For us, people of technology, it became obvious that the fate of the launch vehicle was predetermined.

The American conquest of the Moon concluded with the flight of Apollo 17, which launched from Cape Canaveral 14 days after the fourth H1 launch, effectively putting a final end to this competition. There was no longer any point in rushing to the Moon; there were no defense tasks, nor scientific ones. With V.P. Glushko's arrival at NPO Energia (as OKB-1 was now called), work on the N1-L3 project was curtailed, and in 1976, this was formalized by a Government Resolution. And so, tanks, compartments, stabilizers, fairings, and fairings were left lying alone in the workshops, reminding us of our troubles and lost health.

But the most important thing was the psychological trauma that befell an entire generation of rocket developers. Many had dedicated ten years to this machine, probably the most valuable years of their lives, ten years of creative uplift, of their intellectual potential. And that is a lot. Think about it — ten years of wasted

effort! Of course, everything learned later, during the creation of Energia, came in handy. But back then, when the prospects were unclear, when there was no confidence in the feasibility of such huge projects, it created a depressing impression.

The project was closed. The test site MIKs emptied, the city of Leninsk fell silent, the factories were in turmoil, and despondency reigned in the design bureaus.

The closure of the project was not just a government paper; it also involved an explanation to the Supreme Soviet, as enormous funds for that time — 4.5 billion rubles — had to be written off. This is how the commissions of the USSR Academy of Sciences began to work, which ultimately “showed” the lack of prospects for the launch vehicle. The conclusion of the commission also bears the signature of Chief Designer V.P. Mishin. So, to be frank and honest, there is no need to blame D.F. Ustinov or L.I. Brezhnev entirely now, because the Resolution stated: “...accept the commission’s proposals...” There you have it!

S.P. Korolev’s and V.P. Mishin’s oldest associate, Pavel Vladimirovich Tsybin, told me, when I asked about his attitude to everything that had happened, that a large part of the blame for the closure lay with the head of the enterprise.

ISS “Buran”

Here I've reached the main topic I want to tell the reader about as objectively as possible. Because behind these words—ISS “Buran,” which were whispered by the developers (everything was terribly secret)—stood hundreds of thousands of fates of those involved in the development of this project. And later, when successful launches occurred, every participant would proudly consider themselves part of this “Buran.” But at the very beginning, few believed in the success of this project, even on the eve of the launch, many thought about the absolute futility of the technical solutions implemented.

ISS “Buran”—the reusable rocket-space system “Buran”—that's what it was called in the first joint resolution of the Central Committee of the CPSU and the Council of Ministers of the USSR dated January 27, 1976, №132-51. It was only later that the wider public would learn that eighty-six ministries and departments and 1286 enterprises across the entire Union participated in creating this system, and that by the time of the launch, even before price liberalization, 15.5 billion rubles of public money had been spent, an enormous sum over ten years. Was it in vain? Even now, many have come to believe that this project had no future, that we were ahead of our time, that the system did not justify itself, and...

And in our turbulent times, there's no time to delve into the essence. If you compare, say, the costs of this project with the costs due to sloppiness, you immediately see that the losses from sloppiness over these years exceeded the costs of the ISS “Buran” by one, no, by two orders of magnitude. These figures were widely published. But they are not remembered. Not remembered, that's all! And as for analyzing—that's just laziness.

The ISS “Buran” was the last gigantic project in the rocket and space activities of the enormous and great power of the USSR. What words were spoken! And the “Burans” stand ready for flight at the Kazakh Baikonur Cosmodrome in a huge hangar, and nearby lie the rockets capable of launching them into space. It was only after the first launch, in a TASS report, that this rocket received its proper name—“Energia,” whose godfather was Academician V.P. Glushko. You arrive at Baikonur, which, like the entire country, is feverish with political changes, you walk through the dying halls of the assembly and testing complex, more like a museum than a workplace, in that fading year of 1992, and your heart bleeds.

Whomever you ask, no one openly criticizes “Buran-Energia,”

no. They speak pretty much the same way, like Academician M.F. Reshetnev: “Buran” is an outstanding technical achievement...” Yes, everyone acknowledges that it is a technical achievement, and I, a person whose entire creative life is connected with these achievements, want to tell what was done to organize these achievements, how much labor was invested in every particle, in the product, in the “ground” (that’s what we called ground systems: the launch complex, the technical position, etc.), how many nerves were spent on disputes, even to the point of academics quarreling, how many errors in design, construction, and manufacturing had to be overcome and corrected, how many co-contractors had to be persuaded and convinced so that those very achievements could be born.

I am confident that my reflections on achievements are not original. For people in engineering in machine tool building, aviation, construction, and other industries, this is not new. Those who managed projects or simply participated in the creation of a tractor, a television, a ship, are familiar with all of this.

I want to talk about the technology and the people who created such a unique complex. Because over time, feelings and memory fade, and people who were not involved in this try to intrude into history, and even blacken their own colleagues.

The author had to work on this topic starting in 1976. First, he was involved in designing the orbital spacecraft “Buran,” starting, as they say, from the axial. He completed a difficult path in design with the release of the preliminary design, and after that, in 1982, reoriented to a purely rocket direction. I think those who sent it on its first flight will write about the creation of the orbital spacecraft, and I wish my friends-shipbuilders, with whom I worked side by side for many years, creative success. I think many will be found not only in NPO “Energia” but also in NPO “Molniya” (our main partner) who will tell about this amazing time, a time of scientific and technical achievements, a time of searches and discoveries, a time of successes and failures—a time of creativity.

NEW LEADERSHIP AND FIRST OUTLINES

May 1974. The ink on the order had not yet dried, but the news that our design bureau had lost its leader was already being spread by employees. The Central Committee of the party, or rather its Politburo, had sufficient reasons for removing the head of a large union enterprise, which TsKBEM (formerly OKB-1) was, and first and foremost, these were the failures with the N1-L3 complex.



Valentin Petrovich Glushko

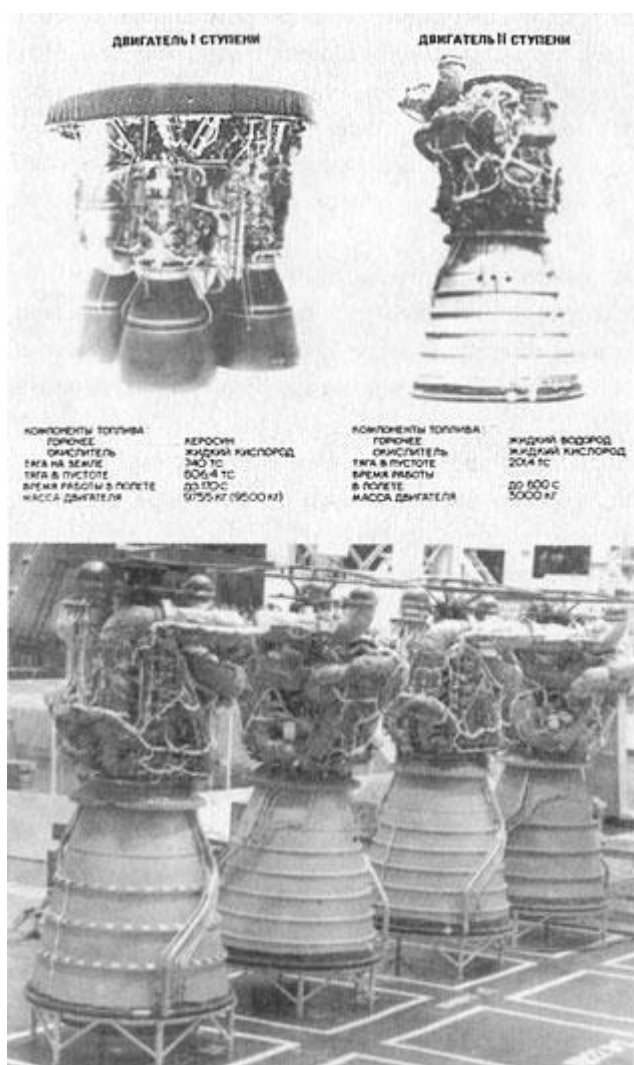
To our great surprise, a “Chaika” pulled up to the main building through the “mousetrap” (as the entrance to the enterprise was called in our everyday language), from which V.P. Glushko emerged. From that day on, he became the General Designer and General Director of the NPO “Energia,” formed on the basis of TsKBEM and the Experimental Machine-Building Design Bureau with its factories.

He quietly walked into the office previously occupied by S.P. Korolev. There were quite a few people in the reception area, and among them was our, now former, chief designer V.P. Mishin. Calling the secretary, Valentin Petrovich instructed her not to let him into the enterprise anymore. This was somewhat shocking.

Gathering the leadership, Valentin Petrovich announced: “I have not come to you empty-handed. We have a lot of work ahead of us on a new series of launch vehicles. These are medium, heavy, and super-heavy class launch vehicles.” And then he began to

elaborate on the engines for such a series, on the unification of standard sizes, on phased development, on the main co-contractors, and on the use of existing groundwork.

Design studies for all options began. In the proposed series of launch vehicles, V.P. Glushko wanted to use the same oxygen-kerosene engine with a thrust of 700 tf on the first stages. This meant that the world's largest liquid-propellant rocket engine had to be created. It should be noted that before this order, the engines created at the Energomash Design Bureau ran on high-boiling components, and now it was necessary to recall oxygen and kerosene again, since almost two decades had passed since the creation of the engine for the R-7 rocket. Credit must be given to V.P. Glushko: he reconsidered his attitude towards the use of liquid hydrogen as fuel for engines and, understanding all its advantages for heavy-class rockets, implemented it for the second stage.



Main engines of the “Energia” launch vehicle and the set of second-stage engines of the “Energia” launch vehicle

Initially, it was planned to use only oxygen-kerosene engines for the entire series of launch vehicles, including for the super-heavy launch vehicle, which was supposed to put a mass of up to 100 tons into Earth orbit. This is exactly the mass needed to create an orbital spacecraft no worse than the American “Space Shuttle.” The designers argued that hydrogen fuel was indispensable. V.P. Glushko convened a meeting and said: “Whoever proposes a launch vehicle option acceptable for an orbital spacecraft, but running on oxygen-kerosene fuel, will be my deputy.” No such person was found. Only after that did he give the go-ahead for the use of hydrogen.

The design of the hydrogen engine was entrusted to one of

Valentin Petrovich's long-time colleagues, Alexander Dmitrievich Konopatov, who headed the Chemical Automation Design Bureau in Voronezh, after which work on new rockets began in our NPO.

Departments previously involved in the design and creation of H1 were reorganized. The most experienced rocket scientist, Ya.P. Kolyako, was appointed acting chief designer of the rocket direction. It was in the departments subordinate to him that the first sketches of new rockets appeared, and various options for their execution were analyzed. The Yuzhnoye Design Bureau, whose General Designer after M.K. Yangel was Vladimir Fedorovich Utkin, joined the creation of the rocket using the basic module.

By the time V.P. Glushko arrived at NPO "Energia," independent areas of work had already been established. These were, first and foremost, the creation of manned spacecraft and long-term orbital stations. All these topics were priorities for our country and became central for the new General Designer. He kept the Chief Designers for these areas, K.D. Bushuev and Yu.P. Semenov, in their positions.

But the Moon gave him no rest. In V.P. Glushko's office, the wall attributes changed, and a map of the Moon was hung. V.P. Glushko studied the lunar globe for a long time until he found a place on it where a chain of small craters on the far side of the Moon had no name. It was there that he sent the future lunar expedition. The laurels of his associates — Korolev, Keldysh, and others — gave him no peace.

A special department for the development of lunar bases was created, headed by I.S. Prudnikov. He was in charge of the design work for the creation of manned lunar spacecraft.

In the early 1970s, we were well aware of the new strategy of our overseas colleagues. This strategy envisioned the creation of reusable launch vehicles that were to replace all existing disposable ones at that time, or, more simply, ballistic and space rockets. For the Space Shuttle system, an aircraft was supposed to be created that would use fuel from an external tank and solid rocket boosters to reach Earth orbit. The shuttle, after deploying a satellite in orbit or retrieving a previously launched satellite, was to return to Earth. Such a system allowed for the deployment of combat space groupings in Earth orbit, including those equipped with weapons of mass destruction. Only such a system could also "roll them up," i.e., return them to Earth when they were no longer needed.

The military confrontation between the two systems continued. The war was moving into space. In the USA, the development of the most modern weapons began, including laser weapons. Large orbital objects were required, their servicing in orbit, including the

replacement of failed spacecraft. Only a system capable of both launching objects into orbit and returning them to Earth could cope with such a task. With the birth of the reusable Space Shuttle system in the USA, a whole program began to be developed, called the “Strategic Defense Initiative” (SDI). In accordance with it, work was carried out on a broad front to create strike and space assets, warning groupings of space and ground basing, and weapons based on new physical principles. The SDI program received the approval of Congress and the President.

With the introduction of SDI, the strategic parity between the superpowers was clearly disrupted, not in our favor. And it was no coincidence that the Americans, already sensing the power of their system, suddenly began to fight for the little-known island of Diego Garcia in the Indian Ocean. It was this island that would stand in the way of the first half-orbit of the Soviet “Shuttle” during an attack on the USA. And they achieved their goal. A new American base was built on the island.

Employees of the Institute for Problems in Mechanics, under the leadership of Academician M.V. Keldysh, analyzed the capabilities of the American system. A memo landed on the desk of the General Secretary of the Communist Party of the Soviet Union, stating that the American shuttle was capable of making lateral maneuvers of up to 2000 km, and even performing “dives,” say, over Moscow, with subsequent return to orbit. This indicated that the USSR was practically deprived of the ability to prevent a nuclear strike or at least warn the population about it.

L.I. Brezhnev’s resolution contained an unequivocal demand to develop a Soviet analogue of such a system. M.V. Keldysh held a special meeting at the Central Research Institute of Machine Building. His report did not evoke enthusiasm from either the institute’s director Yu.A. Mozzhorin or our General Designer. “But they will force us to do it,” the President of the USSR Academy of Sciences concluded. After some time, the leadership of our country proposed to V.P. Glushko to work on a Soviet alternative to this system. Thus, with the arrival of Valentin Petrovich, the fifth direction of work on reusable systems appeared. It was headed by I.N. Sadovsky.

V.P. Glushko owed his appointment as General Designer of NPO “Energia” to D.F. Ustinov, whose friend he had long been considered. Moreover, the appointment took place, as they say, without the approval of the Minister of General Machine Building S.A. Afanasyev, who, in contrast, appointed “his” man, Yu.N. Trufanov, as the first deputy General Designer. In space technology, there were always strained relations between the Chief Designers

and the ministry. This was natural. The Chief Designers, who had huge creative plans, wanted to implement a lot and quickly, while the minister, who well understood the production capabilities of the industry, had to optimize the appetites of the venerable and authoritative leaders. Yu.N. Trufanov's role was precisely to report in time and promote his, the minister's, position at the enterprise. And Yuri Trufanov himself, who had experience as a leading designer for the "Proton" rocket, was not new to our business.

How did the design bureau team receive the arrival of the new leaders? Frankly, very reservedly. After all, everyone still remembered the work style of S.P. Korolev and V.P. Mishin, remembered the formation of the design bureau, remembered that practically every year TASS announcements expressed gratitude to the workers, designers, and scientists who created a new space miracle. And each of them understood that this was meant for Him.

And even if there were failures in rocket affairs, things were going well in manned spaceflight. And our space was glorified almost daily thanks to the fact that all of them were members of a powerful team, a team with certain traditions, a team selflessly devoted to its work, a team for whom S.P. (as S.P. Korolev was respectfully called) became a technical idol, respect for whom only intensified after his death. It was into such a team that Academician V.P. Glushko came. It was as if the scriptwriter of "Taming the Fire" foresaw that his engine-designer associate should take the place of the Chief Designer after him.

V.P. Glushko did not break or reorganize anything in the design bureau. He didn't even change his secretary, understanding that few others could quickly find the necessary person in the multi-thousand-strong design bureau and connect them by phone with the "top." His punctuality amazed many. If a meeting was scheduled for 11:45, one could confidently enter at that time, knowing for sure that V.P. was waiting. And during the allotted meeting time, I never saw anyone interrupt or distract him by phone. How he achieved this — only God knows.

He gave his instructions in a quiet voice and, as a rule, in the form of a request:

"How much time do you need to do this?" he asked. And when they said — one day or two days, he would invariably clarify:

"So, we'll meet in a day? Good, that will be October fifteenth. At what time? Would fifteen hundred hours suit you? Yes? Good."

He would open his small notebook and make notes in it. This meant that one could come precisely at 15:00 without further notification. Sometimes circumstances prevented him from meeting at the appointed time. But there was never a case where he didn't

warn about it in advance and arrange a new date.

And that notebook? At times we were ready to steal it, because it was very difficult to change the characteristics we ourselves had named once they were in it. Of course, it was possible, but it required detailed explanations. Clarity of thought, colossal memory, aristocratic upbringing, an academic, yes, precisely an academic approach to solving any problem, persistence bordering on unyielding stubbornness, the ability to see the main point in both small and large problems — all these traits were inherent in this 66-year-old leader.

Valentin Petrovich literally “tortured” you about every new decision being made! He knew how to argue so well that you felt like you had “gone astray.” Only after a detailed examination would he give his “okay” to a particular technical solution.

He carefully read every document before signing it. Being fluent in Russian, he could not tolerate grammatical errors in reports, explanatory notes, and even more so in letters to co-contractors and higher authorities. As a rule, before going to Glushko, the literati would gather and thoroughly check the text. Nevertheless, typos occurred, and documents were returned silently. The executor would pick them up from the General Designer’s desk under his indignant gaze.

His neatness in demeanor, clothing, and phrasing simply amazed us. I cannot even imagine V.P. having a missing button, wrinkled trousers, or an old-fashioned tie. He paid the closest attention to his clothing.

And how he taught us proper speech! Even now, on television, you can hear the expression “as of today” from an announcer (!): “No, dear sirs, there is no such expression in the Russian language,” Valentin Petrovich told the employees for the first time. “It’s a tautology.” And if it was repeated, he simply suggested leaving the office. That’s how he weaned us off another common word — “kvártal” (stress on the first syllable), explaining that in Russian there is only “kvartál” (stress on the second syllable). Any visit to the General Designer required everyone to be collected, to rethink their proposals once more, to recheck their “scribbling,” and to align the figures. And this meant that other leaders also demanded respectful and serious attitudes toward their duties from their subordinates.

V.P. did not walk through the halls, did not reprimand those who were late, but if someone failed to follow his instructions, or if work fell through, or if he heard any leader make a disrespectful remark about space technology, that person ceased to exist for him. He simply would not receive them, and their career would end.

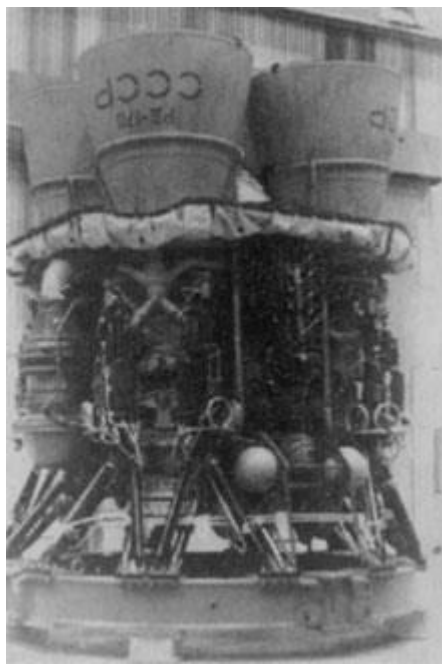
Sometimes he would simply call the head of the personnel department and instruct them to “block” someone’s access. And all this without shouting, in a quiet and calm voice. More than one leader turned pale at his words, “It’s impossible to work with you.”

This was a new style of leadership. Many did not like it. They decided to make it clear that the team did not favor the newcomer. Thus, at the very first party conference after his candidacy was put forward for the party committee, 135 black balls were cast. A little more — and half, meaning he would not have passed into the party committee. By old standards, this meant that he could not lead the team.

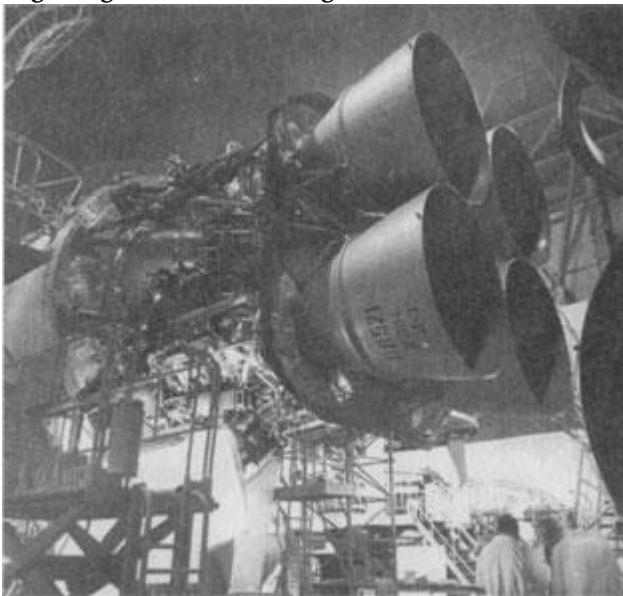
I remember how the voting results were announced, how he sat in the presidium. Nothing betrayed his agitation. Everyone was simply amazed. And a few months later, we learned that our V.P. Glushko had become a member of the Central Committee of the party. It probably wasn’t without D.F. Ustinov’s support.

Valentin Petrovich became more and more involved in the life of our design bureau every day. At the very next conference, only one random delegate voted against him. V.P. Glushko’s authority in the team grew hyperbolically. He entrusted the leadership of “his” old firm to V.P. Radovsky.

The super-powerful engine was difficult to create. Failures simply plagued the team of experienced engine designers. And the General Designer set aside one day a week to analyze and summarize what had been done with everyone, and then approve the next constructive change or improvement. After all, the fate of the entire series of launch vehicles depended on the engine.



First stage engine of the “Energia” launch vehicle



The 11D521 liquid-propellant rocket engine is installed on the first stage block of the “Energia” launch vehicle

The General Designer’s instructions were usually handled by his first deputy. Practically always after a meeting with V.P., he would invite everyone to his office across the hall to finally distribute what everyone needed to do. At the same time, he paid great attention to illustrating the solutions, or, more simply, asked for the solution to be depicted in large scale on a poster, saying:

“There’s no need to rush, but everything should be ready by morning.” And the time, as a rule, was already nine in the evening. So sometimes we had to spend the night at the design bureau, preparing these damned posters.

The first deputy did not meddle in technical matters. He didn’t care if the orbit deviated from the launch point or if fires occurred in the turbopump unit. He knew only one thing — this should not happen. “You must do everything not to upset the General. As for what to do — go and think,” he instructed.

The five areas of work did not last long. After the Resolution on the development of the Buran reusable space system was issued in early 1976, the design department of E.A. Dubinsky and R.K. Ivanov, along with A.G. Karas’s department (this was the name of the military procurement department), began working on the tactical and technical requirements for the Soviet reusable system. General requirements, requirements for the rocket, requirements for the spacecraft, and special military requirements were formulated in separate volumes. The documents were approved at the highest level — by D.F. Ustinov, Secretary of the Central Committee of the CPSU for defense issues. They were symbolically approved on the day of the greatest holiday of the Soviet Union — November 7, 1976. Work on the Buran reusable space system began to encompass an increasingly large part of the design bureau, as entire industries of co-contractors were connected to it, and, first and foremost, the Ministry of Aviation Industry as the lead for the orbital spacecraft’s airframe and a number of its systems. In the Ministry of Aviation Industry, a special design bureau was created for the design of the orbital spacecraft — NPO Molniya, headed by G.E. Lozino-Lozinsky.

By this time, two directions were formed in our design bureau. One — for manned spacecraft and long-term stations, and the other — for the Buran reusable space system. The rocket direction merged into reusable systems. Two first deputies of the General Designer were appointed: chief designers Yu.P. Semenov and I.N. Sadovsky. The design bureau seemed to be divided into two parts, but it did not fall apart. The General Designer firmly held the overall leadership in his hands.



V.M. Filin and I.N. Sadovsky

Igor Nikolaevich Sadovsky is one of the most experienced designers of the Design Bureau. He worked with S.P. Korolev. He was responsible for the creation of the first solid-propellant ballistic missile. Rockets of his design served in the Soviet Army for decades. Under his editorship, a whole series of books dedicated to the American Space Shuttle system was published. But it's one thing to write about them, and another to design a similar system here.

The first projects of "Trufo-plane" and "Glukholet," made by people with great imagination, have already gone into the archives. It was necessary to create something real, not a parachute "stake," not an American "iron," but our own rocket and our own orbital spacecraft. I.N. Sadovsky hesitated for a long time about where to place the second-stage main engines — on the rocket or the spacecraft, as the Americans did.

A huge number of volumes of documentation have already been issued by co-contractors (more than a hundred of them), but the appearance of the rocket is still in doubt. Monoblock or four-tank variant of the central block? So they went to defend the technical project with the four-tank variant. And only two days before the defense, on Saturday and Sunday, everything was turned upside down again. Monoblock.

The installation of launch facilities is already underway, but the location for the second-stage engines has not been chosen. Aircraft or rocket? Doubts, doubts, doubts. And all this in secret. God forbid HE finds out. But Valentin Petrovich had no doubts. Only a rocket and an orbital spacecraft! Create a super-powerful rocket within the framework of the reusable space system! This will be our main trump card against the Americans.

The development of the first stage engine was delayed due to technical reasons. Failures followed one after another. The Minister asked V.P. to move to Khimki for now. The Chief Designer again had doubts about the reusable space system. An engine of such

thrust, with increased specific characteristics, could not be made. It had to be quartered. The author of the ill-fated MD-180 was also found at the Energomash Design Bureau. He began work in this direction on the personal instructions of the Minister.

Failures in the creation of the engine were particularly hard on the Yuzhnoye Design Bureau. After all, the flight tests of their rocket with this engine were supposed to precede the Buran tests. After all, it would later become one of the four side boosters. Many independent tasks were assigned to this rocket, but there was still no engine.

The role of Chief Designer of the Buran reusable space system was, after all, beyond I.N. Sadovsky's capabilities. He was a good designer, deeply versed in complex theoretical issues, but the organization of work in the design bureau, the organization of production, and especially the work of numerous co-contractors — this was like a “sharp knife” to him.

The Chief Designer of the manned direction, Yu.P. Semenov, “pulled the blanket over himself” and even felt jealous of the General Designer himself if any decisions were made in his absence regarding his direction. He concentrated not only design and engineering tasks but also organizational tasks in his hands. His main assistants were the leading designers of specific products. They were the ones who resolved all issues at the interface of production and design, developed numerous schedules, and monitored their execution, ensuring that no change in the product went unnoticed by the Chief Designer.

Regarding the reusable space system, the Chief Designer did not have such a sense of ownership. This led to the appearance of various CCRs (Centers for Work Coordination) and GORs (Operational Management Groups) with their countless meetings, at which the Chief Designer himself reported. He did not ask, but rather reported.

More and more different industries were drawn to the topic of the Soviet “Shuttle.” Designing a product is only half the battle. It is necessary to organize production, not only of the launch vehicle but also of all ground systems: launch pads, test stands, technological equipment, airfields, control and monitoring points.

By resolutions of the Central Committee of the CPSU and the Council of Ministers, an Interdepartmental Coordination Council (MVKS) was created to coordinate the work, headed by the Minister of General Machine Building S.A. Afanasyev. It included ministers of defense industries, representatives of practically all industrial ministries, and, of course, military departments. The decisions of the MVKS had the force of Government Resolutions.

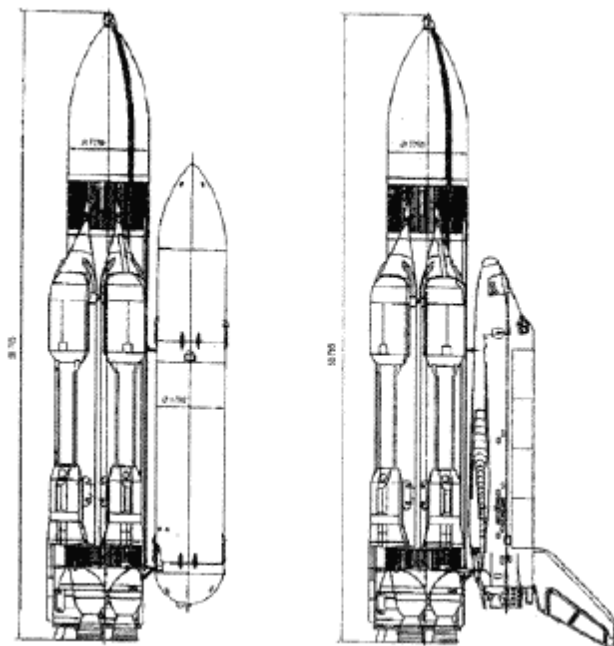
The progress of the work was constantly monitored by the bodies of the Central Committee of the CPSU and the KGB, and not only monitored — the existing system allowed for prompt intervention and effective assistance. After all, I repeat, the security of our country was at stake first and foremost.

In 1979, the system's configuration was finally determined and confirmed by a released supplement to the preliminary design. The orbital spacecraft was very similar in shape to the American one, but without main engines in the aft section.

The rocket was a package, in the center of which was the second stage with four single-chamber engines operating on liquid hydrogen and liquid oxygen. Four first-stage boosters and the orbital spacecraft were docked to the central block along the periphery. The boosters, operating on kerosene and liquid oxygen, were equipped with one four-chamber liquid rocket engine. Yes, the very one mentioned at the beginning of this section.

The entire package was mounted on a transitional launch-docking block, which provided most of the hydraulic, power, and pneumatic connections with ground systems. The launch mass of the package reached 2300 tons — almost 40 railway cars.

A new, perhaps the most crucial, stage in the creation of the reusable space system began, not counting flight tests — ground experimental development. This required a clear organization of the manufacture of flight models and test objects, and the coordination of all work, including the conduct of the tests themselves, in terms of execution deadlines.



The “Energia” launch vehicle, on an external suspension, can launch the “Buran” orbital spacecraft or a cargo transport container with a diameter of 6.7 m, which houses large-sized cargo and an upper stage.

Constant technical wrangling over modifications to the hardware of test objects greatly unnerved the design bureau team and co-contractors. The moment came when the Chief Designer was clearly overwhelmed. Understanding this, he wrote a letter of resignation. The resignation was not accepted. However, the General Designer decided to transfer part of the work on the reusable space system, namely, on the orbital spacecraft, to Yu.P. Semenov’s service. This did not bring much joy. At that moment, work on the Mir orbital station was in full swing. And here was a 100-ton spacecraft, and also the NPO Molniya co-contractor. But the decision was made. The design department for the spacecraft came under the subordination of Yu.P. Semenov.

I had many years of work experience with the designers of this department. We worked side by side for about 20 years. I came to this team as an engineer, and in it, I became the deputy head of the department. These people, at different times, developed the Elektron satellite, the first Soviet space reconnaissance vehicles, lunar spacecraft, and automatic stations for exploring Mars and Venus. This department gathered truly gifted people, in love with space, and all of them ended up in one department to create an orbital spacecraft — one of the most technically complex objects of

a reusable system. I still remember the gentle but demanding Boris Sotnikov, the excellent and highly experienced layout designers V.F. Sadovoy, A.A. Kalashyan, and T.A. Pryanishnikova, as well as the good-natured O.P. Kozyupa. It was he who marked the landing point of Yu.A. Gagarin's descent module with a metal crowbar, as evidenced by a photograph in the enterprise's museum.

I recall A.V. Egorov, who designed the orbital spacecraft's docking module down to the smallest detail, which later interested the Americans.

And the team of systems engineers led by Yu.M. Frumkin, who developed the spacecraft's flight program, reviewed thousands of abnormal situations, created hundreds of directive control logics, calculated the necessary energy requirements of all spacecraft systems, and ensured the fulfillment of numerous technical specifications! This department also employed V.P. Burdakov and V.G. Aliev, with a small staff of employees who began working on the spacecraft literally from the very first days. In addition to technical conditions, these people managed to "manage" the aviation means of transporting large-sized compartments of the system.



Yuri Pavlovich Semenov

But fate decreed otherwise. As always unexpectedly, news came of the appointment of Boris Ivanovich Gubanov as chief designer for the entire reusable space system and for the rocket in our design bureau. He had previously worked at the Yuzhnoye Design Bureau as the first deputy general designer. He later recalled that he himself had not expected such a rapid change of events.

B.I. Gubanov had extensive experience in technical leadership, defended his doctoral dissertation, and received the high title of Hero of Socialist Labor for the development of combat missile systems. His candidacy was strong from all points of view. True, B.I.

Gubanov, when agreeing to his transfer to NPO “Energiya,” did not suspect that V.P. Glushko already had one first deputy. He learned about this when he came to work at the NPO. Incidentally, Yu.P. Semenov also came to our design bureau from Dnepropetrovsk, but we forgot about it and considered him one of our own.

B.I. Gubanov and Yu.P. Semenov knew each other well. Once, they spent more than a month in the taiga at the impact point of telemetry warheads of combat missiles. It seems fate brought them together again.

And one more transformation I want to mention. In the late 1970s, V.D. Vachnadze became the General Director of NPO “Energiya.” Performing the functions of both General Designer and General Director was (if one can say so) not to V.P. Glushko’s liking. So he agreed to the appointment of a General Director. His duties included resolving production and economic issues, of which there were hundreds every day at the huge enterprise. Vakhtang Dmitrievich worked at our factory for a long time, rising to chief engineer. Then he was the chief engineer of the Main Directorate, and now he returned to us as General Director. Since technical issues were under the purview of the General Designer, Vakhtang Dmitrievich did not have a decisive influence on them. Communication with the “top” also remained with Glushko. Thus, the General Director practically became the second director of the experimental factory. But thanks to his simple communication style, he was accessible to any employee of both the design bureau and the factory. I still don’t remember a case where he didn’t help someone, especially if the person was in trouble.

FIRST DIGRESSION

Every person has their own character, abilities, and views. These are formed from childhood, school, studies, and work. This should not be refuted. I want to tell you about one particular character. I would call it a win-win. Let's imagine: a product is being created, be it furniture or an airplane, a combine harvester or a rocket.

There are people who want their product to be good, elegant, and, of course, reliable. From the first lines on the drawing, they treat it like their own child. After all, the product needs to be taught to work, and to work long and flawlessly. And they believe that the product they are creating will not fail.

But there are also other "creators" who stand nearby, as if helping the first ones in their difficult task. Unlike the first, they simply do not believe in success. They constantly warn that this is not right, and that too was not done in the best way, sometimes mockingly scoffing at the creators. True developers have to overcome not only technical difficulties, but also psychological barriers that these "pseudo-creators" firmly build before management. Incompetent management likes this. After all, they are presented with the idea each time that in case of problems, he — the manager — is innocent.

Such "creators" do not lose. They know the proverb well: "The winner is not judged." And indeed, if there is success, everyone forgets about their disbelief, but if there is failure, then they are on top. After all, they warned, they said, they predicted. And with what pleasure they begin to work in commissions investigating various incidents, accidents, and they work thoroughly. And since technical errors are quickly identified, they direct all their intellectual power towards well-educated people, truly passionate about the cause. It is these people who hinder their careers, and these are the ones they remove from their path. Such "judges" are usually vindictive. And if those who have ever opposed them can be considered sinners, then humiliating and even spitting on such a "win-win" brings special pleasure. Considering themselves brilliant and indispensable, they sometimes achieve significant career heights, leaving behind incompetent leaders, thereby showing their greatness.

Our design bureau was no exception.

ENTRY

It was surprisingly easy to write about the past. But now I'm moving on to the main thing I wanted to talk about. I don't know where to start. So many technical problems that had to be overcome, so many everyday situations, so many production issues, so many people—not hundreds, not thousands, but tens of thousands—are still fresh in my memory that it makes me uneasy. My memory has not yet filtered and organized these truly historical events. And the main danger here is not to offend anyone.



Boris Ivanovich Gubanov

Spring 1982. The workday was coming to an end. Bright sun shone into the window of my office. Due to the heat, I had to keep the door open. Unfamiliar voices in the corridor put me on alert. I looked at the door, expecting to see those whose voices came from the corridor. V.D. Vachnadze, B.I. Gubanov, I.N. Sadovsky appeared in the doorway. It turned out to be an inspection of the design service, which was headed by the first deputy General Designer, chief designer of the Buran MCC, B.I. Gubanov. And now he was also becoming the head of the design service, which dealt with both the launch vehicle and complex issues for the MCC as a whole. The orbital spacecraft had been transferred to another service only three months ago, which was headed by Yu.P. Semenov with the same ranks.

- Hello! — said Boris Ivanovich, seeing me.
- Hello, — I replied, standing up.
- Do you work here?
- Yes.
- That's good.

— Of course, — I was indeed very happy. After all, Boris Ivanovich and I had developed good working relationships during the development of the Lunar program.

The fact is that the rocket block for the Lunar spacecraft — block E — was developed by the Yuzhnoye Design Bureau, and for the last few years, B.I. Gubanov was responsible for it. Since I was involved in general issues of the Lunar spacecraft, I was personally entrusted with supervising the work on this block in Dnepropetrovsk. I had to share all the difficulties and joys of creation with this team, from the technical specifications to the last flight test. I had to spend about a week a month in Dnepropetrovsk. I developed friendly business relations with almost all employees of the Yuzhnoye Design Bureau. But B.I. Gubanov provided special assistance to me, a simple engineer, in solving problems. And there were a lot of such problems. For example, the tanks were already welded. General assembly begins. And then I, “all in white,” — our ballistics experts suggest increasing the volumes. And it begins... You walk from drawing board to drawing board, from desk to desk, from one boss to another. Everyone understands that it’s necessary. But no one dares to take responsibility for the changes. The roads always led to B.I. Gubanov. And if he approved, then the further path to M.K. Yangel or V.F. Utkin became simple. He himself reported and received consent for such a modification. I don’t remember a case where he rejected a competent technical solution for any political reasons. And now he is in our Design Bureau.

— I ask you to come to my office in the evening, — he said, and the procession moved on to inspect the design halls, to meet the heads of departments and sectors. The deputy chief designer Ivan Ivanovich Maksimov also accompanied them. A very kind person. He was responsible for coordinating work and experimental development.

The workday ended. I waited another half hour. I called. He wasn’t there. I waited longer. Seven in the evening. He appeared.

— Come in half an hour, — he answered on the phone. Half an hour later, I entered.

— Sorry it didn’t work out earlier. I wanted to ask you, where have I ended up? How is your organization structured? I can’t seem to understand.

I briefly told B.I. Gubanov about our structure. Much of it was a revelation to him.

— Can you put everything you’ve told me on paper?

— Yes.

— But I also ask you to express your opinion on the proposed structure, so that things move more actively. What is your current

position?

— Deputy head of the design department.

— Will you be my deputy?

— That's impossible now.

— Why?

— Three months ago, my department was transferred to Yuri Pavlovich's subordination. And now I can only give consent with his permission.

— Alright. I'll take care of that question. And you don't get agitated or fuss. I'll tell you when it's time. I'll talk to Semenov and Glushko.

It was late evening. Around 9 o'clock. I didn't even imagine then that finishing my work at this time would be the norm for the next ten years.



Developers who started designing the Energia launch vehicle.

A.K. Samokhvalova, R.V. Gorbenko, P.V. Tsybin, L.E.

Kogramova, B.P. Sotskov, I.P. Firsov, I.M. Amelin, R.D.

Dolgopyatov, V.V. Liberman, V.N. Sokolov, V.S. Mikhailov, B.A.

Tanyushin, P.I. Ermolaev, V.V. Ivanik, V.M. Danilovich, Ya.P.

Kolyako, S.S. Rozanov, E.L. Gorbenko, G.K. Akimov, V.A. Udaltsov,

V.A. Vysokov, V.A. Areshkevich, R.K. Ivanov

I had to think a lot before making such a choice. From the spacecraft department, I'm moving to the rocket direction. It seems like all the people are familiar, but something is scratching inside. After all, I have to leave my department.

But only one thing pushed me to make the final decision. This was the work on the Lunar spacecraft. Ten years were dedicated to

its development. The Lunnik was built, went through a full cycle of development, even tests in space. It was completely ready for a flight to the Moon.

The rocket failed, it never flew once. So I thought: I'll give another ten years to the orbital spacecraft, but what if it's in vain?! What if the rocket doesn't fly again?! Intuition told me that I needed to move on. I had enough work experience. But I was perfectly aware that my figure didn't determine anything, that success depended on those people who had already gained experience with the H1. It's not for nothing that they say that two inexperienced people are worth one experienced one. It was the developers of the H1 super-rocket who could foresee all unforeseen circumstances, the whole complex of issues, the solution of which was the key to success. V.A. Udaltsov, R.D. Dolgopyatov, V.V. Liberman, B.A. Tanyushin, P.I. Ermolaev, I.P. Firsov — they were the ones who spent their best years creating the H1. The project was closed, the material part was written off. But how to heal the psychological trauma inflicted on the developers? After all, they had to start all over again. And how to design without believing in success? It would take about five years to readjust.

A few days later, Yu.P. Semenov called me and asked for my opinion on B.I. Gubanov's proposal. I answered something. But in the end, he gave his approval for my transfer to the rocket engineers. So I returned again to what I was taught at the institute — to rocket design.

Upon arriving at the Design Bureau, B.I. Gubanov, having extensive experience in creating combat missiles, quickly sorted out the technical issues. He carefully studied all the embedded solutions. Among his merits, it should also be noted that he did not begin to revise the appearance of the rocket, but, believing in it, began to deploy its production and development on a broad front.

Usually, a new Chief Designer introduced changes to the product, thereby historically asserting his creativity. But the understanding that any change would affect not only the creation deadlines, cause doubts among our co-contractors, as well as confidence in the solutions embedded in the rocket by Korolev's team, allowed Gubanov to soberly assess the situation and, probably, overcome unnecessary self-love.

In May 1982, I was appointed Deputy Chief Designer of the MCC for work coordination and experimental development. As a result, I had to start this work practically from scratch. Let me remind you that under I.N. Sadovsky, this function was performed by a special unit under the General Designer.

The Chief Designer is the master of his product, and he simply

has no right not to have information about its condition.

The creation of the Soviet reusable rocket and space system was elevated to the rank of a national task. At NPO Energia, the aircraft fleet was expanded to ensure operational communication with the test site and numerous co-contractors. Three TU-134 aircraft, two AN-12s, an AN-24 and an AN-26, and also an IL-76. At Vnukovo, we were allocated a site called Vnukovo-3. The entire aircraft fleet was commanded by Colonel General M.I. Samokhin, who came to the Design Bureau at the personal request of S.P. Korolev and enjoyed enormous authority in aviation circles. One phone call was enough, and the next morning the plane was ready to fly to any point in the Union.

B.I. Gubanov immediately took advantage of this. First, he made trips to all our main co-contractors. These visits were of great importance. After all, one personal meeting always brings an order of magnitude more benefit than hundreds of letters. In 1982 alone, we made hundreds of one-day trips to the chief designers-developers. In the morning, a flight, say, to Voronezh to the engine design bureau of A.D. Konopatov. We meet, outline a program of joint work. Back in the evening. We learned to fly to Kuibyshev, Kharkov, Dnepropetrovsk so often that we even forgot to warn our families that we were going on a business trip. We also visited the entire Moscow region — the enterprises of V.P. Barmin, Yu.A. Karneev, V.P. Radovsky, O.A. Sulimov, and others.

It must be said that everywhere we were met kindly and, as a rule, assured that their firms would not let us down. Although the chief designers of these firms were well acquainted with B.I. Gubanov from his work at the Yuzhnoye Design Bureau, the fact that he visited them in a new capacity — as the Chief Designer of such a giant system — contributed to good business relations.

In the course of my story, I will recall our wonderful co-contractors many times, but it's time to move on.

SAMARA RESIDENTS

Our designers, deeply aware of the bitter experience of creating the H1 rocket, when they moved to flight tests without a sufficient number of ground tests, created a comprehensive program for the experimental development of the new rocket.

The program consisted of three stages. The first stage involved testing processes related to fueling the rocket. The second involved fire tests on experimental setups, and the third involved tests confirming the results of flight tests and the actual flight design tests. The success of the final test depended on the quality of tests on individual setups (and there were hundreds of them).

A huge volume of ground test work was ahead. But to get to them, it was necessary to manufacture test objects and experimental setups.

The main plant for the manufacture, assembly, and testing of the rocket was designated the Kuibyshev “Progress” plant, led by Anatoly Alekseevich Chizhov, where more than thirty thousand people worked and continue to work. A branch of the plant was also located in Baikonur.

The “Progress” plant traces its origins back to the Moscow “Dux” plant, founded in 1893 and specializing in the production of bicycles, motorcycles, automobiles, aerosleds, and railway draisines. In the 20th century, this plant began producing French aircraft—more than two thousand were built. During Soviet rule, it was State Aviation Plant No. 1, which produced more than sixteen different types of aircraft before the Great Patriotic War.

In 1941, the plant was evacuated from Moscow to Kuibyshev. Already in December, three IL-2 attack aircraft and 27 MiG-3 fighters were produced at the new site. In total, 17,275 aircraft were built at the plant during the war years! This is approximately 17 aircraft per day. Think about that number—17 aircraft per day.

In 1946, the production of jet fighter aircraft was mastered. 1958 marked the beginning of the production of rocket and space technology. This is where the serial production of the R-7 rocket was transferred, a modification of which is still produced today. This plant also manufactured the Lunar super-rocket, and it was not the fault of the workers that it did not fly. After all, everything that was required to be done and tested according to the Chief Designer’s documentation, they did with honor. Even after the topic was closed, they handled the remnants of the material part in a хозяйский (resourceful) manner, using them for garages, gazebos,

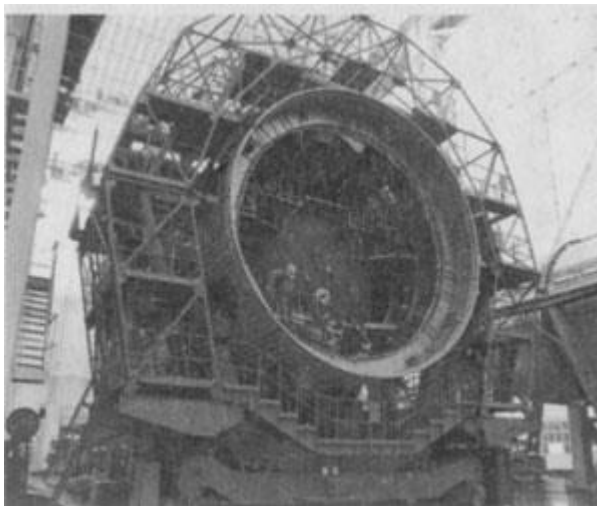
drainage systems, etc.

The plant experienced the closure of the Lunar program with bitterness and pain, and if it happened in our time, it is unlikely that the workers would agree to participate in the creation of a new super-rocket. But in the era of socialism and a planned economy, by a Government Decree, they were entrusted with the manufacture of the “Buran” rocket.

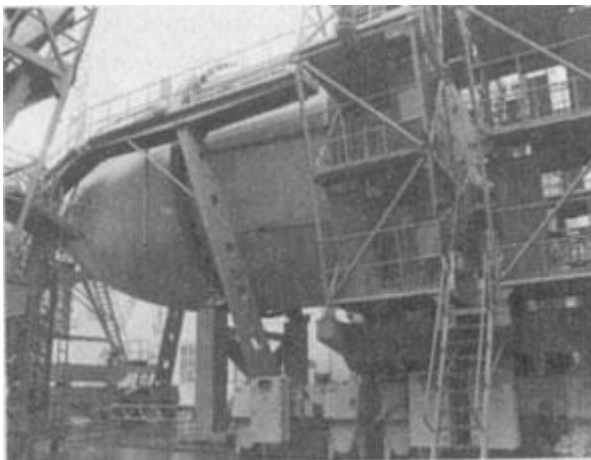
Undoubtedly, reorganization of production was needed. A huge building was specially constructed for the assembly of the central block, its dimensions astonishing even experienced workers. After all, it was in this building that individual petals of the fuel tanks had to be bent and milled, frames manufactured, tanks welded, and thermal insulation applied, and this for a hydrogen tank 40 m long and about 8 m in diameter. To imagine this diameter, it is enough to look into a subway tunnel: it is approximately 6 m.

But manufacturing the tanks is only half the battle. They also need to be tested for strength on a static stand and on a special stand at low cryogenic temperatures. This means that the stands must also be of appropriate sizes. A lot of work lies ahead, and all of this falls on the shoulders of Chief Engineer V.N. Mentyukov. Tight deadlines, daily reports to the minister, supply disruptions, complications with equipment commissioning—and all this on one scrawny chief engineer. Only good erudition and willpower helped him to endure.

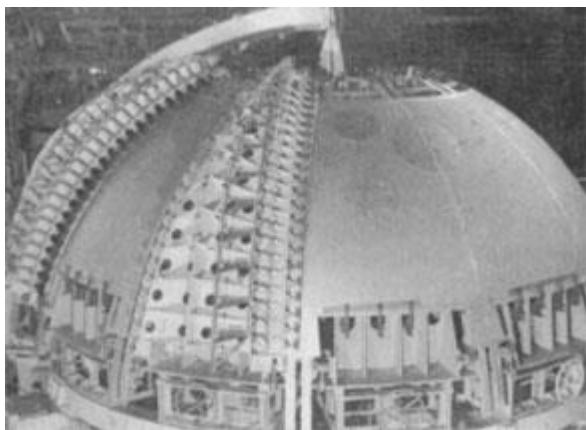
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Intertank compartment of the second stage of the “Energia” launch vehicle on assembly and welding equipment during docking with the oxidizer tank



Oxidizer tank of the second stage of the “Energia” launch vehicle in the assembly and docking stand, ensuring the assembly of the upper half-block



Jig for assembly-welding of meridional seams of spherical bottoms

During the creation of the H1 rocket, the manufacturing of which, as I have already mentioned, took place at the same plant in Kuibyshev, a specialized branch of TsKB EM already existed. This small team was engaged in solving all issues related to organizing the serial production of the R-7 rocket at the “Progress” plant. It was headed by Dmitry Ilyich Kozlov, who previously worked for S.P. Korolev at OKB-1 as the lead designer for this rocket. Subsequently, the design bureau significantly expanded and, in addition to supporting the serial production of rockets, became a developer of national space control systems. The turn came for the “Energia” rocket. This is where, as I call it, the psychological trauma manifested itself. The team could not overcome it after the failures with H1. D.I. Kozlov focused on developing an independent direction and supervising the R-7 rocket in production, and did not want to hear about participating in the creation of the Buran MCC. He simply did not believe that such a complex technical problem could be solved.

Even after the success of the first launches, Dmitry Ilyich “shouted” at all levels about the uselessness of its creation. But I don’t think he didn’t understand the military-political situation at that time.

It was necessary to organize a branch of the design bureau again. Boris Georgievich Penzin took on this task. The Volga branch was created at NPO “Energia”. It was later this branch, numbering just over a thousand people, that released all the design documentation for the second stage. The volume of documentation was such that even two “Energia” rockets would hardly have been able to lift it off the ground. And initially, there were only about 300 people.

“Strength engineers” are being selected. It is their lot to carry

out countless calculations and tests. Oh, those strength assemblies, which received their designation 2I. There were more than thirty of them in total: they were loaded, pressed, broken—and only to check the correctness of the chosen solutions. Individual assemblies were sent for testing to the Central Research Institute of Machine Building (TsNIIMash)—the leading enterprise in the industry, which issued the final conclusion on strength.



September 1984 — 10 years since the formation of the Volga branch. In the foreground N.I. Rumyantsev, B.G. Penzin

They were manufactured in Kuibyshev, and tested in the Moscow region. It seems like nothing special, but remember the dimensions! You can't use the railway, you can't transport by plane, so river transport remains. A special barge is built. It later served to transport the orbital vehicle from the manufacturer in Tushino for testing in Zhukovsky. But the barge could not reach the test stands. They turned to helicopter pilots. They asked them to transfer the test tanks from the Pestovsky reservoir near Moscow to the receiving sites of TsNIIMash. Thus, to the astonishment of the residents of Kaliningrad near Moscow, huge Mi-10 helicopters carried equally massive tanks on external slings over their heads. It seems like nothing unusual. But for this, it was then necessary to solve many organizational issues for pilots, river workers, and state farm workers, on whose land the receiving site was organized, and for testers regarding the expansion of entrance gates, etc.

It must be said that the Kuibyshev "strength engineers" led by A.V. Andreev were persistent, even stubborn people. They had good support from the chief designer B.I. Gubanov. To all questions from

above, whether it was possible to do without these tests to shorten the deadlines, they answered: “No.” Often, at the instructions of the ministry, revisions were carried out on the solutions laid down in the design documentation. Commissions followed one after another. And the “strength engineers” firmly stood their ground.

I tried to show, using just one example of testing frame compartments at TsNIIMash, what a huge number of diverse issues had to be resolved. And the same thing happened with every assembly.

And how did the designers of the tank and frame compartments, and fittings feel?! Arriving in Kuibyshev, you see that, in addition to directly issuing drawings, they also spend days and nights in the workshops, promptly resolving emerging production issues. P.I. Kirsanov, a good organizer and, as we say, a technician, spared neither himself nor others. Everyone worked selflessly and responsibly. Later, S.A. Petrenko, the developer of oxygen fittings, told about one group leader.



Overloading 2I assemblies from a barge for helicopter transport to the strength test base

Once, approaching the checkpoint, he met him smoking one cigarette after another. To the question of what happened, the employee replied that he was going to the HR department to resign. He was like a ball of nerves.

“Tell me more,” Stanislav Alexandrovich asked.

“I made a mistake.”

“What kind?”

“I mixed up the fittings on the pneumatic panel.”

“Which one?”

He named the number. Each element in a rocket has its own designation.

“I mixed up the input with the output.”

The defect was indeed serious.

“How did this happen?”

“I don’t know. I trusted the technician. I saw it already in metal.”

“Wait, don’t worry. Don’t go anywhere, let’s go to work. We’ll figure it out there.”

“I won’t go.”

“Stop being silly! Let’s go.”

Immediately to the workshop, they looked at the pneumatic panel. The error was obvious. In the evening, the panel had to be sent to the test site for assembly. A one-day delay would cause a scandal.

They called the developers of the pneumatic diagram. Together they began to think about what to do. They found a solution. Considering that the inlet and outlet lines had only a check valve inside, they decided to swap the supply lines and put the valve under special control.

I am specifically telling this story to give at least a small sense of the atmosphere and mood that prevailed in the design departments.

There were two testing services in the branch. One dealt with testing experimental setups and control testing of tank systems (E.N. Shcherbak), the second with electro-pneumatic testing of the standard product (A.A. Markin). The sense of responsibility in both departments was great: after all, they were releasing standard products for flight.

The main design bureau of NPO “Energia,” which developed the system project, needed to timely supply the Volga branch with the necessary initial data for issuing working documentation. They had to transmit the results of ballistic calculations, report on all types of loads and features of aerodynamic impact, provide data on thermal and gas-dynamic calculations, ensure all types of engine connections with the block structures, determine the requirements for the placement of control and measurement equipment, and report the results of calculations and requirements for separation elements. A.G. Reshetin and A.A. Zhidyaev carefully monitored this.

Special attention, both in our GKB and in the Volga branch, and at the “Progress” plant, was paid to the thermal insulation of tanks and pipelines. What is its composition, how to apply it? All this was new. V.I. Ryzhikov had to sweat for more than a month in

the plant workshops.

This was one of the most serious problems. Its essence lies in the fact that the temperature of liquid hydrogen is -253°C , 60° lower than the temperature of liquid air. This means that if liquid hydrogen is poured into the tank, liquid air will flow down its outer walls, which will turn into ice after some time. And what will happen inside the vessel? Powerful heat flows will go to the liquid hydrogen poured into the tank. This is like wrapping a tightly closed pot of water with a heated coil. Boiling will begin, pressure will rise, and the vessel will rupture.

Now let's imagine our hydrogen tank made of thin-walled waffle shells. Its diameter is about 8 m (which is 2 m larger than the diameter of a subway tunnel), and its length is about 40 m. Such a tank can hold enough liquid to give every resident of Moscow a glass. Filled with liquid hydrogen, the tank poses a huge danger. If it explodes, it will be equivalent to the explosion of 300 tons of trinitrotoluene—five railway cars!

Of course, the first thing that comes to mind here is to insulate the tank from the external environment, and in such a way that heat inflows are minimal. However, a large thickness, and consequently, the mass of thermal insulation reduces the useful payload delivered to orbit. This means that the thermal insulation material must be such as to ensure its high efficiency with small thicknesses. The thermal insulation must adhere well to the tank, be elastic, i.e., stretch and compress together with the tank metal, because during fueling, due to temperature differences, the hydrogen tank changes its dimensions in length by almost 0.5 m. It is also necessary that the applied thermal insulation withstand several cycles of hydrogen fueling and draining from the tank.

Existing insulation materials could not be found. So, the chemists were tasked with creating the necessary material. The Americans had it—a similar situation on the Shuttle. But the system was being created in our country, and, as always in rocket technology, the main condition was that only domestic materials should be used in the developed system. And this led to the need not only to invent the composition of the thermal insulation material with the desired properties but also to organize its industrial production.

The composition was found, quite light, moderately elastic, and technological. It was named "Ripor." It was enough to apply a 30 mm layer to the tank surface to achieve the necessary storage conditions. But how to apply it to the tank surface?

A number of special experimental setups were created, from a single sample to a modeling tank, on which hundreds of

experiments on applying thermal insulation were carried out. Recommendations for repairing and defecting insulation were also given. But how to apply such insulation to a real huge tank? After all, its thickness should be only 30 mm, and the tolerance of 1 mm, set by our designers, was quite strict.

Initially, they tried to glue the thermal insulation in the form of separate mats, but it turned out uneven, clumsy, and with gaps between the plates. A special machine had to be created at the “Progress” plant. The fully assembled tank was installed in it and rotated. A carriage moved along the tank, spraying thermal insulation, followed by a second carriage with a cutter, which machined this 8-meter “log” 40 m long to the specified dimensions. This way, the necessary requirements could be met.

It was more difficult with the application of thermal insulation to pipelines. This process could not be mechanized, so special brigades had to be created, which manually applied the insulation, cutting off the excess with ordinary large knives.

The tanks are ready, the frames are riveted, all this needs to be delivered to Baikonur. Many different methods of delivering such large-sized cargo were considered: both water and land. But it was concluded that air transport would be the most expedient. Existing aircraft could not cope with this. V.P. Glushko contacted O.K. Antonov and asked him to develop a special aircraft for the reusable system. O.K. Antonov agreed. Thus, to the Resolution on the creation of the Buran MCC, a Resolution was added for the development of a new aircraft within this system, first the AN-124, and then the AN-225, a six-engine aircraft capable of lifting about 100 tons of cargo into the air. The development of the giant aircraft and the Buran MCC are practically comparable in terms of deadlines and technical problems.

What to do now? They worked out a variant for transporting large-sized cargo based on the 3M aircraft designed by V.M. Myasishchev, which was designated 3MT.

Why this particular aircraft? After all, it was put into operation in 1953 as a strategic bomber. Wasn't it outdated?

Analysis showed that it could carry a cargo of about 45 tons on its “back.” At the same time, its flight characteristics would decrease by 40%, but would remain quite acceptable, and when compared to an orbital vehicle, even almost three times higher. The placement of the cargo above the fuselage required not only spreading the vertical tail but also lengthening the fuselage itself. In record time, the aircraft was modified at the M.V. Khrunichev plant and the experimental machine-building plant. Numerous wind tunnel tests confirmed the correctness of the chosen path. TsAGI

also conducted its strength tests. Preparation was complete. Flight training was necessary.

And how many doubts there were about using this aircraft for transporting large-sized cargo! An aircraft with a fuselage diameter of 3 m, transporting a hydrogen tank with a diameter of 8 m, looked like an ant carrying a large egg.

The head of TsAGI, G.P. Svishchev, after seeing the first outlines, said that such an aircraft would never fly. He even shamed those who proposed it, as discrediting the name of the general designer V.M. Myasishchev. The Minister of Aviation Industry, P.V. Dementyev, also did not want to hear about this method of transportation, promising to “strangle” with his own hands those who came up with such an option.

Our employees V.P. Burdakov and V.G. Aliev went with N.F. Kuznetsov to V.M. Myasishchev and asked him to consider the possibility of transporting rocket blocks on his aircraft. Myasishchev promised to give an answer in two weeks.



Installation of the fuel tank of the second stage of the “Energia” launch vehicle on the 3MT transport aircraft



Air transportation of the fuel tank of the second stage of the “Energia” launch vehicle from the manufacturer to the cosmodrome
And two weeks later, an express report was presented, showing

the possibility of transporting large blocks on the 3MT aircraft.

Even from our institute days, we knew V.M. Myasishchev as one of the most gifted aircraft designers, a proponent of using unusual, original solutions in aircraft construction.

He, along with his deputy A.D. Tokhunts, supported the idea of transporting our cargo on the “back” of the 3MT.

The minister summoned G.E. Lozino-Lozinsky and A.D. Tokhunts to, as he put it, “strangle them with his own hands.” Ominous clouds gathered over their heads. The minister was not to be trifled with. The evening before, A.D. Tokhunts called V.P. Glushko and told him everything.

“So he said he would strangle you with his own hands?” V.P. asked again and laughed for a long time.

“You go to Pyotr Vasilyevich tomorrow and don’t worry,” he concluded.

In the morning, pale and distraught, G.E. Lozino-Lozinsky and A.D. Tokhunts appeared before the minister. He was very agitated.

“Comrades! You know, D.F. Ustinov just called and, on behalf of the Central Committee of the CPSU, sincerely thanked us for the found method of transportation. This is a high evaluation of our work. Who is the author? Present all the materials to me.”

They pointed to A.D. Tokhunts.

“We need to arrange a personal salary for this.”

And they did.

And here, V.P. Glushko helped to get out of a difficult situation. It was he who called D.F. Ustinov and asked for his help. And Ustinov’s word was very weighty in those days. Tokhunts, upon returning, called V.P. Glushko.

“Well, didn’t they tear your head off?” he asked with irony.

“No. I sincerely thank you,” Tokhunts replied.

For transportation of the second stage to Baikonur, it was initially planned to deliver the hydrogen tank, then the oxygen tank along with the intertank and tail section frames. In other words, the 3MT aircraft delivered the central block completely to the test site in two flights. Placing such bulky and heavy cargo on the back of an aircraft is not an easy task. Therefore, special gantry cranes (PKU) capable of lifting and placing cargo up to 50 tons on the aircraft are being built in Zhukovsky (the aircraft’s home port), Kuibyshev, and Baikonur.

The first cargo was a hydrogen tank with a fairing and a drainer. It was specially manufactured for flight testing of the aircraft and crew training.

By barge along the Volga, Oka, and Moscow rivers, the cargo arrives at V.M. Myasishchev’s organization, where it is installed on

the aircraft. From a distance, it looks like one large barrel with wings tied to it. The fuselage is lost under the enormous cargo. The first taxiing.

How will the machine behave?! The day of the first takeoff approaches. The run-up, a dark plume from the engines, and the entire assembly is in the air. This happened on January 6, 1982. The test pilots are met as true heroes. And indeed, if something had happened... — one does not want to think about it. Dozens of flights passed, and the path for the rocket to the test site was open.

The first cargoes to fly are the fueling articles. This has become customary for rocket scientists. An obligatory stage in development, called cold (fueling) operations, is the checking of all ground systems, checking their readiness to work with the article, and the actual fueling. And this rocket is being fueled for the first time with such a huge amount of liquid hydrogen and oxygen.

In my story, I pay more attention to the creation of the second stage; the rocket modules of the first stage were developed at NPO “Yuzhnoye.” And although their fuel components were well known, I know that there were enough large and small problems there too, before they reached the stage of fueling tests.

THE PROVING GROUND, FIRST MEETINGS

Time flies by unnoticed. I thought it was just yesterday that I finished the last line of the previous chapter, but a whole month has already passed. And not a single line! It's simply amazing. I didn't even think about working on the book. Routine work consumes me and doesn't allow me to concentrate and conduct even the smallest analysis of what has passed. And then there's the situation at Baikonur... The military practically admitted their helplessness in further supporting the work on the Buran ISS project, and we need to think about how to save this historic cosmodrome.

The cosmodrome, to which fate brought me back in September 1982, and which for over a decade was my second home, so dear that sometimes I forgot I was on a business trip. Good or bad? I don't know, but it's definitely a native place that constantly draws me back.

Baikonur. It's not just the colors of the sky, not just the intoxicatingly fresh air, but also exhausting work. Work that, despite physical fatigue, provides inner satisfaction. After all, every day brings something useful. Every day another bit of your labor is invested in something majestic and unforgettable. At the cosmodrome, the road to work is subject to military regulations. This draws us, civilians (as they call us here, "jackets"), into their rhythm.

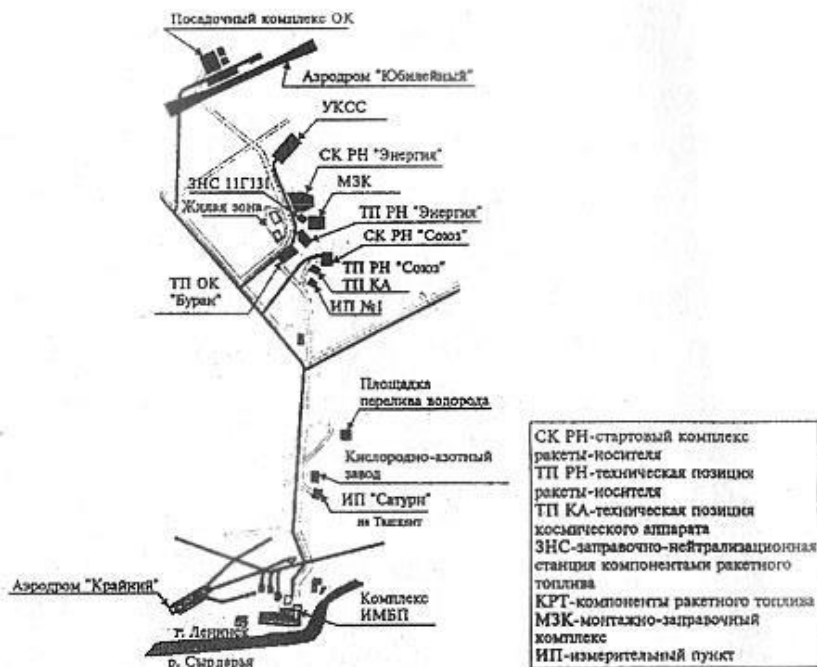
Morning "motor trains," like snakes, crawl out from site 10 and majestically move across the steppe, like caravans of ships on the water's surface. These green ribbons of trains first follow each other, preventing anyone from getting lost along the way, and, reaching a fork, scatter in different directions, delivering people who are already coming to their senses to the steppe towns.



And in the morning, another motor train.

Work at the cosmodrome on the ISS project gained more and

more momentum. There were more than ten thousand builders and installers alone. After all, it was necessary to build the orbital vehicle landing complex, and the universal stand-start complex, and launch positions, and technical positions, and fueling complexes, and, of course, residential buildings. After all, the project was developed not for one flight, but at least for 30 flights a year. And this means that there would be thousands of service personnel. Everyone needed to be provided with normal living conditions. A huge burden fell on military builders.



Situational diagram of the Baikonur Cosmodrome



Baikonur Roads

The Interdepartmental Coordination Council, headed by Minister of General Machine Building S.A. Afanasyev, closely monitored the progress of construction and work on all components of the Buran system. Field meetings were especially productive. S.A.

Afanashev would “put” all members of the council on a plane, and it included several other union ministers, and fly to the cosmodrome. All objects would be toured, and then a powerful “dressing down” at the meeting. Practically everyone got it, as deadlines were missed by many. The first flight of Buran, according to the general schedule, was supposed to take place no later than 1984. But that was according to the schedule. Reality spoke of something else. So, the working schedules turned into mobilizing ones.

A cavalcade of cars moved from object to object. As a rule, all members of the ICC were in a bus, and behind the bus was a whole string of cars. These were the heads of work from different organizations, commanders of construction units and administrations. In essence, the ICC was like a small council of ministers, and its decisions (according to the council’s regulations) had the force of Government Decrees. 15 union ministries were represented in the ICC either by the ministers themselves, such as I.S. Silayev, E.K. Pervyshin, P.S. Pleshakov, P.V. Finogenov, V.V. Bakin, or by their deputies. The main industrial sectors: aviation, radio, communications, defense, chemical, instrument engineering, heavy machine building and energy, were united by the interdepartmental coordination council. In fact, this council involved all union republics, 86 ministries and departments, and more than 1200 enterprises in the development of the Buran ISS. The entire huge country, with a mechanism finely tuned over many years, rose to develop a national task. After all, according to military strategy, combat operations were moving into space. And only those who controlled space could make others reckon with them. It was only later that people would ask why Buran was built. But if it hadn’t been for it, it’s completely unclear how history would have developed.

The role of the ICC in creating the reusable Buran system was enormous. And if something was written in its decision, one could be calm — it would be fulfilled.

That is why preparations for the council meetings at the cosmodrome were so thorough. The preparation itself forced all performers to look around, summarize results, and clarify the situation with their co-contractors in a working manner. And if necessary, warn them in advance about what to “roll a barrel” on. True, there were also cases when, without warning a particular performer, an unprepared question was raised at the council. But as a result, an intolerable atmosphere was created around the one who wanted to deflect the blow from himself and set up others, so much so that he was forced to change his place of work.

In November 1982, after another meeting, B.I. Gubanov called me over:

— I have a request for you. I need to go to Moscow, and you know, a decision has been made to strengthen the leadership of the work at the cosmodrome. Stay. I'll be back in a week.

What is a Chief Designer's request? It's well known. It's an order.

— All right.

So, having arrived for three days, I stayed at the cosmodrome for almost three months. They say here that nothing is sweeter than the dust from under the wheels of a departing boss. The cavalcade of cars rushed to the airfield, and everyone seemed to exhale, scattering to their holes.

I started to analyze. Was everything done in Moscow, at the design bureau? After all, the reorganization of the service had just been completed. I had quite well strengthened the department of lead designers. To the experienced S.S. Yershov, V.D. Semenov, S.A. Tarasov, I added new employees: K.K. Popov, A.N. Voronov, O.N. Sinitsa. I had known some of them since my student days, and had worked with others for over ten years. I was fully confident that they would bring a fresh perspective to the work of the leads and would not let me down.

I also went to the hotel at site 2. To my surprise, the hotel was closed. I knocked on the duty officer's door. She explained that by order of M.I. Samokhin, after the main delegation left, the administrators were dismissed and the hotel was closed. "Grandpa," as we called Mikhail Ivanovich, always knew exactly who was flying out and who was flying in. My return was unexpected. So they gave me the key to the front door. I went into my room. Uncomfortable. I went to the dining room — closed. I returned. Heated some tea. Turned on the TV, but my thoughts were racing like crazy, because for the first time I had been entrusted with such a huge job. I needed to pull myself together.

In the morning, I went to the MIK — the assembly and testing facility. In front of the MIK was a small 3-story building. The engineering building. This building, and the MIK itself, were built during the H1 era. Here, on the second floor, were the offices of the Chief Designers of our main co-contractors, as well as the offices of the Minister and the Head of the Main Procurement Directorate of the Ministry of Defense. In their absence, their authorized representatives worked here. In one of these rooms was the office of the General Designer of NPO Energia. I entered. I met Yu.M. Danilov. During the construction of the technical position, he had occupied this office. I had known Yu.M. Danilov since the time I

worked at the proving ground preparing for the launch of the T2K — an analog of the Lunar module — to test its systems in Earth orbit. Since then, Yuri Mikhailovich had practically not left the cosmodrome, living with his family at site 10 (Leninsk). After the closure of H1, V.P. Glushko was appointed responsible for the creation of the technical complex by NPO Energia. He knew the intricacies of cosmodrome life down to the smallest detail. His advice was very useful.

— Hello! How did you end up here? — Yuri wondered.

— By chance, — I laughed.

— And for how long?

— Forever.

— Well, finally. I was fending for everyone here alone.

— Now we'll attack together!



Yu.M. Danilov

He briefly outlined the state of affairs at all facilities. And much of it was a revelation to me. After all, the reports to the ICC painted a more favorable picture, as everyone embellished their affairs a little in their reports.

— You should gather all the lead contractors, — Yuri Mikhailovich advised, — and talk to them frankly. Find the right language with them. The launch is still a long way off, but we will have to work together.

He immediately dotted the “i”s, as if defining the leading role of Service 16 — the Chief Designer’s service for the Buran ISS. I immediately felt uneasy. I had an understanding of rockets, of spacecraft, but here I was being “burdened” with questions about

the UKSS (universal stand-start complex) and the SK (launch complex), and the erector, and the OK (orbital vehicle) landing complex, and so on, that is, about all components of the system, as a deputy Chief Designer.

— You need to sit in this office. Just ask Valentin Petrovich for permission for that. I asked, — Danilov advised.

Yes, V.P. Glushko's office was the most equipped, both in terms of furnishings and communications. At the cosmodrome, communication was a big deal. And here there was operational communication, internal MIK communication, ZAS communication, and especially valuable HF communication. You could dial a disk with the emblem and find yourself at any industrial enterprise in the Union, be it in the Far East or Ukraine, Uzbekistan or Leningrad, Moscow or Perm. Excellent communication.

— I'm here temporarily. For the duration of construction. You need to think right away and draw a diagram of the premises, showing whose office will be where.

We talked about living conditions, about transport, and then parted ways. We sat with our guys in the next room and started thinking about where to begin. It was necessary to indicate that a permanent representative of the Chief Designer had appeared at the TK (technical complex). Since the time of S.P. Korolev, the Chief Designer had been a significant figure at the cosmodrome, a person who was treated with great respect and even feared.

We planned to hold a meeting the day after tomorrow. And to explain the plans for the near future once again. I went to the 6th Directorate of the proving ground. I was met by the acting commander, Colonel Nikolai Andreevich Borisyyuk, a good-natured giant with an open face and sly eyes. He began to talk about how much everyone missed real work. After all, since the time of H1, they had not had any active work, and many were in despair. I also told him about our plans. I announced that by December, the first rocket would be assembled for fueling, and in January 1983, we would take it to the UKSS for work. He listened, and a subtle smile flickered across his face. He knew very well that it would be another couple of years before the product went for testing. Even the railway tracks were not yet ready, not to mention the erector and the stand itself.

The acquaintance was made, and we assured each other of close and friendly cooperation.

We gathered for a meeting. We got acquainted. The director of the Progress plant branch, V.E. Kravchenko, the director of the ZEM branch, Yu.I. Lygin, V.V. Lazarev from V.P. Barmin's company, A.A. Makarov from NIIkhimmash, and V.V. Studnev from NPO Molniya

came.

— We have one task. To deliver fueling product 4M to the UKSS no later than December 31, 1982, — I said, opening the meeting.

A heavy silence fell.

— And the product, in our opinion, will not make it, — V.V. Lazarev replied.

Thus began the exchange of information. Everyone asked more about others' affairs than they spoke about their own. The meeting continued.

— It will make it. And how are your affairs going?

— We won't fall behind the product, — he assured, and looked at everyone.

Everyone didn't want to fall behind, to be the last one, so they found out what others were doing. For some reason, everyone sitting at the table tried not to look at each other. This game of imagined leadership lasted almost until the launch itself. Those gathered well understood the enormous difficulties that had to be overcome before the product "went" to the UKSS or the launch complex.

The acquaintance was made. Everyone dispersed. It was necessary to work on the assembly schedule of the product. Lead designers V.E. Bugrov, Ya.P. Khorev drew up schedules, but it was extremely difficult to obtain information about the assembly cycles of the central block from the factory technologists. They themselves barely understood what it would lead to. After all, only empty rocket shells were at the proving ground for now.

Only a specialist will understand that behind the outwardly elegant and simple forms of a rocket lie hundreds, no, thousands of pipelines, instruments, aggregates, and that in the central block alone, more than 450 different valves of 80 varieties are installed.

Before entering the product, each type of fitting underwent such tests that, for example, even oil workers found them fantastic. First, design tests, then finishing tests, reliability tests, and finally, each valve underwent control tests. And this was across the entire range of parameters and conditions of their functioning as part of the rocket. Not a single valve had the right to fail, because the life of the rocket "hung" on it.

But let's recall the test conditions once again. Only the temperature of liquid oxygen and liquid hydrogen, which are -193 and -254°C, excluded the use of rubber and synthetic materials as seals, allowing only metal; the working conditions were not easy: vibrations, overloads, high pressures, minimal response times, and this despite the fact that the cross-sectional dimensions of some

valves exceeded 300 mm.

Our valve specialists A.M. Shcherbakov, A.N. Voltsifer, Yu.P. Ilyin, V.F. Nefedov, V.V. Volsky and others had to work hard for a long time before original solutions were found for each hydrogen valve. The oxygen system was developed in Kuibyshev. The future chief designer of the branch, S.A. Petrenko, headed this department.

But all this is somewhere far away, in the west. And we are in the steppe, and we needed ready-made valves that could be installed in place in the rocket, not mock-ups and samples for testing. The delay in manufacturing fittings was the largest in the overall cycle. At the Progress plant, a special valve shop is being created on the instructions of Minister S.A. Afanasyev. The valves will come. But when?

In addition to valves, pipes were needed to connect these hundreds of valves, engines, and tanks into a single system — the propulsion unit. The task of product 4M was to learn how to fuel this propulsion unit with liquid oxygen and hydrogen, with a total mass of over 700 tons.

Hydrogen posed a particular danger. From school, we know about detonating gas. So, it must be handled with extreme care. Special studies by the State Institute of Applied Chemistry showed that if there is a 4% hydrogen impurity near the product, an explosion is inevitable, as an ignition source will always be found. Therefore, the entire central block was designed to prevent even minimal leakage. All pipe and valve joints on the rocket were welded. Welding was performed by special welding machines. First, a sample was welded, and then the same crew went to the rocket and welded the standard joint without changing modes. Then, X-ray of the joint, leak test of the welded section, and its acceptance.



Assembly and testing facility for the Energia launch vehicle.
First stage block assembly bay

Any valve has moving elements, which means that fuel components can leak through them when the valve is repositioned. To avoid these accidental leaks, the fittings were placed in pneumatic shields. These pneumatic shields were purged with inert gas, which prevented hydrogen accumulation in them due to accidental leaks.

And the pipeline didn't go straight to the product. First, the configuration was taken, then a mock-up was bent, the technology was worked out on it, and then three standard samples were made at once. One went for testing, where it was brought to destruction, another — on board, the third — as a sample for the next machine. The pipelines were fitted to the joint so precisely that even a safety razor blade could not pass through. No tension or bending on site! So, one can imagine what efforts it took to manufacture each pipeline. But all this can be done if there is something to work with.

But then, in October 1982, only tanks and skeletal compartments (as we called the inter-tank compartment and the tail compartment) lay in the jigs. And the jigs themselves were not yet ready for the final assembly of the blocks. All components: pipelines, pneumatic shields, individual fittings, hydraulic power

units, and turbogenerators — everything was on the mainland at factories, where a fierce struggle was underway to create these components. Practically all factories in the industry were involved in the manufacture of pipelines.

But ramping up production is no easy task. And here we are at the cosmodrome, waiting for these ill-fated components.

The situation with the side boosters was also extremely difficult. Their modular part was unified with the first stage of the Zenit launch vehicle developed by the Yuzhnoye Design Bureau. And since the development of Zenit was ahead of Energia, its production was also ahead.

Mock-ups of the modular parts for the fueling product arrived from Dnepropetrovsk simultaneously with the central block tanks, but the tail and nose sections for them were clearly delayed. These sections had a riveted structure, and to rivet them, jigs were needed. So, by this time, they had not yet been designed at the Experimental Machine Building Plant of NPO Energia.

S.A. Afanasyev, Chairman of the ICC, was well aware of this.

— You understand, you're letting everyone down, — he called the plant director A.A. Borisenko. — If you don't catch up and don't deliver the sections to the proving ground in two months, you'll go to the board, — he said and hung up.

Deliver eight compartments! In two months! That's impossible to do, even if all other orders are stopped. A solution had to be found. They found one. The machine was not for flight, but for ground use. And that meant there was no need to fight for mass. Someone suggested machining these compartments from a blank. Of course, he was ridiculed. First, there were no such blanks, and no such machines either. But the idea had already taken root. They remembered Atommash. Machined tail sections were within its capabilities.

It's a pity that the nose sections couldn't be machined; they had to be urgently made according to standard documentation, i.e., riveted.

The times of administrative rule were not so bad. One call to the instructor of the Central Committee of the CPSU, Vyacheslav Grigorievich Krasavtsev — and our representatives were already expected in Rostov-on-Don. Yu.I. Lygin and A.N. Ivannikov got on a plane and flew. At the gangway, they were met by the regional committee secretary I.A. Bondarenko, and on the same day, they were in Volgodonsk. Everyone understood: since the Central Committee intervened, it was a matter of state importance. They inspected the production, made arrangements, drew up documents, and began to return. Before departure, all those seeing them off

were invited onto the plane (fortunately, it was their own plane), where, as expected, a table was set, and, raising their glasses, they thanked them for the reception and understanding. The “farewell drink” was normal, so they parted as friends. Such “farewell drinks” contribute to mutual understanding under any regime. And it must be said that the Volgodonsk residents did not let them down. The sections were sent on time.

A week passed since my arrival at Baikonur, and then I received a high-frequency telegram stating that my Chief was coming, and with him, the heads of the complexes. He specifically brought them to the proving ground because many did not fully grasp the scope of the work. Demonstrating the entire panorama of construction, assembly, and installation was the best assessment for them. After such trips, one no longer wants to think abstractly that you have a year or two in reserve, that you can still play with options. No, you already understand that you can become the “last one,” and that is very unpleasant.

For some reason, at that moment, I recalled a slogan in the collegium hall of the Ministry of General Machine Building: “He who does not want to work seeks reasons, he who wants to work seeks ways.”

The next day, I’m going to meet them!

— Well, how are you doing here? — asked B.I. Gubanov.

— Fine, we’ve developed a schedule, and I’ve made contact with everyone.



Yu.N. Koptev

Yu.N. Koptev — head of the 3rd main directorate, future general director of the Russian Space Agency, A.N. Ivannikov — V.P. Glushko's deputy for work coordination, members of the CCR (Work Coordination Center) and heads of departments arrived with B.I. Gubanov. We went to lunch.

Since the founding of the proving ground, a “dry law” had somehow unofficially been in effect at the sites, and if an engineer was caught tipsy, he could be expelled from the proving ground within 24 hours with obvious consequences.

But here, everyone was openly invited to the dining room. The dining room belonged to the military trade organization, but the “staff” was entirely from our enterprise, and therefore we considered it our own.

Tables are set. The appetizers are rich: fried bighead carp, saiga meat, vinaigrettes, cabbage, and vodka.

— I knew that good, successful endeavors end with a feast. But to see great endeavors begin with a drinking party, I see for the first time, — Yu.I. Lygin exclaimed. Everyone laughed heartily, but no one refused either the vodka or the appetizers. After the first one, it became quiet, and it seemed everyone pondered: indeed, a great task lies ahead, and there are still many years until the launch, but will it be successful? Will the fate of H1 strike us? One doesn't want to dwell on the past, but if there are doubts and no confidence, it's better not to start.

But then the table gradually began to disperse, it became noisy, and jokes started flying. A young Armenian, A.L. Gevorkyan, skillfully kept the company entertained with his wit. It was he who later had to lead the assemblers of the side boosters. They were called “carrots.” Why? I still don't know. They weren't red, and their shape was far from a carrot. But they were “carrots,” and that was that.

The morning greeted us with a slight frost and a gentle breeze, the kind that seems to wash over every bone in your body. The head of the main department gathered everyone. He announced that, by order of the minister, we would stay here until the end of the year, until we assembled the machine. We walked through the workshops, outlined the daily routine. A very strict regime was introduced. Operational meetings at 9:00 AM and 8:00 PM. Saturday was a working day, and Sunday until 3:00 PM. Later, this became the norm. But at first, it was hard to believe that it would be like this.

— What else is there to do at the proving ground but work? — they said on the mainland. — There aren't even any women there. Just work to your heart's content.

Yes, there is truth in those words. The workers had not yet brought their families, and in general, no women were seen. Mostly men worked in the halls. Light work was far off.

The next day, the Chief approaches and says:

— Listen, I wanted to replace you, but I urgently need to go to Moscow. We can't leave the head of the main department alone. Stay here a little longer.

— All right, — I reply.

— Get in touch with Koptev. He can help us a lot. After all, the factories “answer” to him. And one more thing. Help P.I. Kirsanov. He often complains about the lack of initial data.

P.I. Kirsanov headed the design team that accompanied the production of the central block and block “Ya” at the proving ground. All designers were from Kuibyshev, from the Volga branch, but the design solutions were laid out in Moscow. Often, clarifying a particular parameter took months. This was unacceptable. I was given the authority to summon anyone from the GKB to the proving ground, make decisions on the spot, and approve them on behalf of the Chief and even the General Designer.

Day after day passed, but no forward movement was felt. A lot of pipes needed to be laid; there were about a thousand of them in the tail section of the central block, and block “Ya” required no less. A week passed, and at the operational meeting, the report was: four pipelines manufactured, ten joints welded. No matter how much Yu.N. Koptev protested, he could not speed things up. He had to “get into” the assembly technology himself, study all the intricacies of manufacturing these cursed pipes, and argue with the directors every day via high-frequency communication.



Assembly jig for the lower adapter of the second stage

— When can you install the group of pipelines for the fire

extinguishing system, — he asked the section foreman, — draw up a schedule and report in the evening.

In the evening, at the operational meeting, the foreman brings his schedule, which shows that the installation will be in ten days.

— Unacceptable. Go, think about it, it needs to be done in two days. Report at 10 PM.

At 10 PM, a schedule with a two-day work cycle is placed on the head of the main department's desk.

— Well, you see, if you think about it, it can be done in two days, — Yuri Nikolaevich notes.

The foreman is silent.

— Sign the schedule and execute it, — the boss declares.

At the morning operational meeting, it turns out that the schedule has not even been put into action. By the evening, it is already quite clear that it is a complete failure. The section foreman is again called “on the carpet.”

— Did you develop the schedule?!

Silence.

— Is your signature on the schedule? Why didn't you complete it? Why are you misleading us? Why did you sign a “fake”?

— You asked, so I signed, — the foreman replies. An outburst of indignation. Dead silence in the office, a tableau.

— Well, alright, — says Yu.N. Koptev, — let's go further. Describe the entire process by operations, standardize it, tell us how to help. And draw a realistic schedule. I'm giving you a verbal reprimand, but be aware, everything can end sadly. I'll expect the schedule tomorrow! That's all. You're free.

And the next day, the same thing. We advanced literally by millimeters.

And again, swearing, persuasion, explanations... Nerves were clearly giving out. A month passed in this wild pace, and it became perfectly clear that the machine would not be ready in December. The minister did not want to understand this; at least an empty mock-up had to be assembled. But there was no Chief Designer's documentation for it. And assembling a mock-up was not such a simple matter. Even empty tanks and compartments weighed tens of tons, and millimeter precision was required for assembling the package. The assembly and installation equipment was not supplied in full, and the crane facilities had not yet been re-equipped. And December came all at once. Now, talking about the product, even a mock-up, in 1982 became problematic. It could be assembled if the units arrived from the Zhdanov plant. We flew to Zhdanov (Mariupol), walked through the workshops, and realized that there was no point in waiting for the units this year.

In the minister's office, our chief of the main department somehow wilted. Who knows the minister, after all! He promised to fire him if we didn't assemble the package and a photograph of the assembled machine wasn't placed on the table at the January board meeting! No photograph, and the board's decision would be entirely different. A week passed, Yu.N. Koptev was summoned to Moscow.

We left the dining room. By the ministerial "Volga," looking somewhat drawn, Yuri Nikolaevich turned to us, the designers:

— I don't want to campaign or explain, but I earnestly ask you: come up with something. We need to assemble the package. I promise a bonus equal to your salary. Just come up with something. I'll be back in three days.

He reluctantly got into the car and drove to the airfield. We ourselves really wanted to see the assembled machine as soon as possible. But how to assemble it? The assembly technology needed to be changed. We started thinking about how to do without docking equipment and perform the assembly without the help of cranes. A variant appeared, but here was the problem: one crane was missing.

We often went to see how things were going with the ground crew. They had completed the erector, the pit was ready, the main concrete work was nearing completion, and large-sized equipment was arriving.

The construction and installation departments faced an enormous task of creating a universal stand-start complex. Even for the first stage, for the functions of the stand alone, they had to put into operation 210 structures, 49 technological systems, and 1653 premises for special technical systems. Alexander Alexandrovich Makarov supervised all this construction. The stand was assigned to NIIkhimmash. Therefore, a special complex was created within it, whose task was to test the Energia launch vehicle on this stand. But before operating the stand, it had to be built. This was the first task facing the 7th complex of NIIkhimmash.

Together with military builders and specialists from Minmontazhspetsstroy, employees of the 7th complex worked hard to put the stand into operation, but under conditions sharply different from ours. After all, they had to work outdoors, in exhausting heat and severe frosts, in construction dust and dirt. We, on the other hand, worked in air-conditioned halls, where everything was polished to a shine, and there was no need to even talk about dust.

How much they had to endure! I wish someone would write about it in more detail.

But now I want to talk about something else. Assembling the

product, even if it's just a dimensional mock-up, before the New Year is no easy task. This task was constantly being solved in our minds. Like an obsessive idea, it had taken root in us, and wherever you were, the thought kept returning to this task. Probably only a strange person would think that the apple that fell on Newton's head inspired him to discover the law of universal gravitation. But creative people know well that Newton thought about this natural phenomenon not for a day, and probably not for a month, but perhaps for years, and the apple only pushed him towards the solution. He collected data bit by bit until it crystallized into a complete idea.

We were far from such great scientists, and the problem was much simpler. Speaking of Newton, I only wanted to remind you that a person is constantly looking for solutions to new and new problems that life presents him with. That's just how he's built. And the world of knowledge is limitless.

One December day, I was driving to San Sanych (A.A. Makarov) to once again exchange information about our affairs. A self-propelled Japanese "Kato" crane was working on one of the assembly sites. The crane itself was simply beautiful. I decided to drive closer. The operator, a man in his fifties, proudly began to talk about the capabilities of this crane. He said that the crane's operation was controlled by an onboard computer, which would suggest its operating mode and block a dangerous operation in time. The crane's lifting capacity, depending on the boom length and angle of inclination, allowed it to lift a maximum weight of up to 40 tons. The soft and precise supply of hydraulic fluid to the power cylinders allowed the suspended hook's movement to be regulated literally to the millimeter.

The first thing that came to mind was — couldn't this amazing crane be used to assemble our Energia? I returned to the MIK, told the technologists about my idea. The first estimates showed that it was possible. I put the technologists in the car and we drove to the crane. We clarified the characteristics. Everything was going in the right direction. We stayed late, redrawing all the operational threads. It might work. The crane is suitable. In the morning, I go to the site again. I start finding out who owns this crane. I go to General A.A. Fedorov at site 10. He listened carefully to us and promised to help.

— We've been building and building for four years, and there's no end in sight. Your product isn't visible. At least show it to the builders faster, — the general said at the end of the conversation.

Now we had to negotiate with the driver-operator himself.

— When do you need it? — he asked.

— Approximately December 27-29 according to our schedule,
— I replied.

— According to the schedule?

— Yes, according to the schedule.

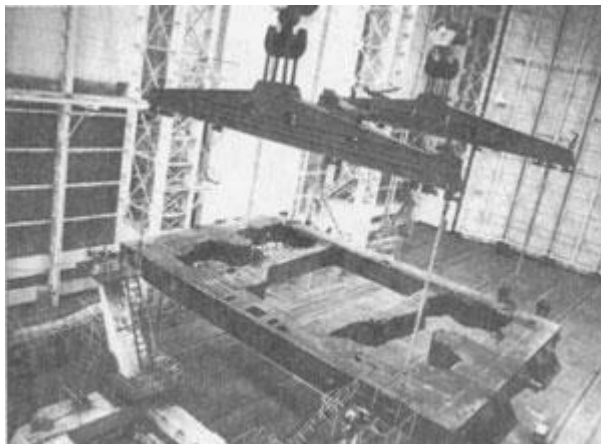
— I can't. I know your schedules. You'll be late, and I'll be left to celebrate New Year's away from my family. And I want to go home.

— We have our own plane, and we will take you to Moscow. We will fly together.

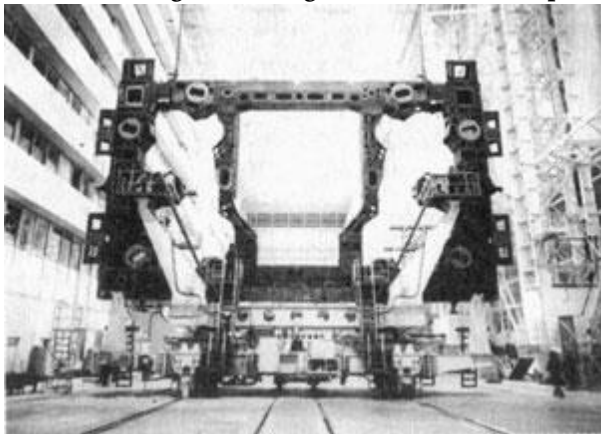
— What if the weather is not suitable for flying? No, I'm flying out on December 25, period.

— Who else can operate this crane?

— No one.



Stages of assembling the Energia launch vehicle package



That's how the problem turned out. There's a decision to assemble the package, but how to implement it? Back to the general.

— Don't worry. The builders won't let you down. The crane will be with you on December 28. Work calmly.

Yu.N. Koptev and B.I. Gubanov returned from Moscow. We met them. The first question at the plane's gangway:

— Is there an option?

— Seems like it.

His face transformed. At the evening operational meeting, issues of package assembly were discussed. There were many of them. The fact was that lifting traverses had started arriving from the factory, and each of them needed to be pressed (loaded with a weight 10% greater than the calculated one, and checked to see if it would break). The power base of the package — block “Ya” — also needed to be pressed. Its brackets had to withstand a load of up to 200 tons (approximately two to three railway cars).

The pre-New Year period was pressing. Operational meetings were moved to the assembly hall. Chief technologist G.Ya. Sonis literally invented new devices every day.

On December 20, the central block was assembled. It was placed on a railway platform and moved to the fourth bay. The fifth bay of the MIK was not yet ready.

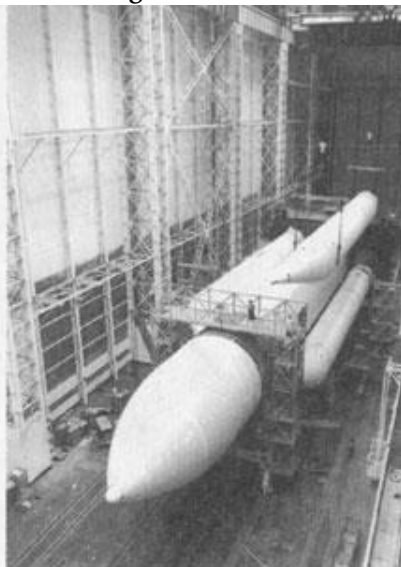
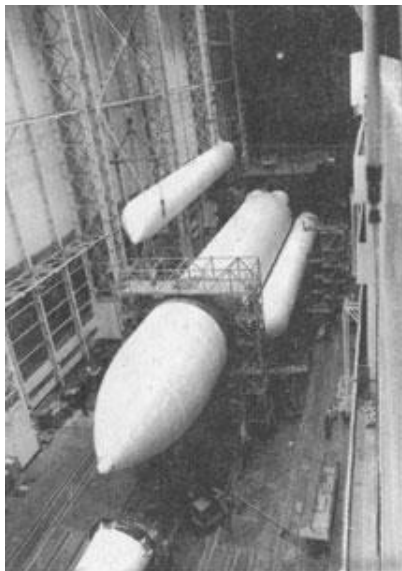
Block “Ya” was also moved to the fourth bay. It was placed vertically, test weights were attached to its lower end, and testing began. During the very first lift, one of the brackets broke.

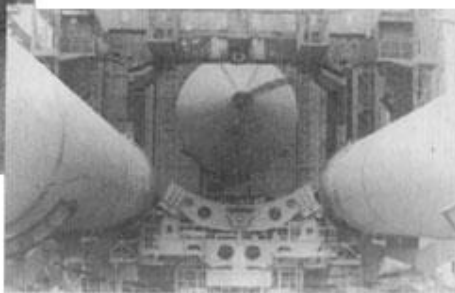
Manufacturing defect. An urgent high-frequency telegram was sent to the factory, and in the morning, a new one was already on the plane. We moved to the fourth bay to the mock-ups of the side boosters. Four days later, everything was ready for package assembly. We did not leave the MIK until the assembly was complete. Five days on our feet. I never thought that the soles of my feet would be the most vulnerable. On the third day, it felt like walking on hot coals. Only sitting briefly on a chair with my feet up helped for a short time. Everyone, without exception, spent days and nights in this fourth bay. And even the arrival of V.V. Lazarev with a report that a rally dedicated to the commissioning of the erector would take place on December 25 at 10 AM could not tear anyone away from the machine. Naturally, this caused offense to our main co-contractors, but I think they understood us well too.

The lower side blocks were laid, the central block was brought up. It was time to install the two upper blocks. The “Kato” crane was needed. Indeed, the general kept his word, and the crane, as we had agreed, stood at the MIK gates. To my surprise, a young man was at the wheel. He drove into the MIK at 10 AM and took the initial position. We explained to him what needed to be done. He quickly understood.

— I'll do it, — he replied, — I have a request for you. Will you give me a little alcohol later? The guys said yours is very good.

- All right. How much?
- About two hundred to three hundred grams.





Stages of assembling the Energia launch vehicle package

Time passed, but the crane work didn't begin. The Chief Designer of the Motor Design Bureau, V.F. Stepanov, doubted one of the traverses. We had to stretch a string and test it again. Time until the New Year was now counted in hours. And here was the string.

Both the head of the main department and the chief of the product even turned pale. But there was nothing to do. It had to be tested.

Assembly again. Night fell. The operator slept peacefully in the "Kato" cabin. Two upper blocks were prepared, already connected to block "Ya," and the final operations for docking the side boosters with block "Ts" at the upper nodes remained. The "Kato" crane began its work. I stood nearby. The guy worked calmly, following all the instructions of foreman Pildes, who was leading the assembly. Gray smoke filled the entire bay. The smell of burning from the "Kato" engines was felt in all bays. The ventilation system couldn't cope. Colonel N.I. Rumyantsev, the senior representative of the customer, couldn't stand it.

— I cannot watch these outrages. I cannot allow it, but I am powerless to forbid it. Do it without me, — he said and left.

The assembly proceeded as usual. Soon, the crane was no longer needed. Having received the promised bottle, the guy, very pleased, drove off.

And the "rolling in" of the central block continued. Its path was

less than a meter, and the clearances for the node's entry were millimeters! We moved 20 mm, and Pildes' words sounded:

— Stop. Measure.

Another hour passed, and again we moved, and so on until 5 AM. It became clear — everything worked out. All that remained was to hang the side rods.

— I'm ready to fulfill my promises. Where do I sign, — Yu.N. Koptev asks me.

— In the office.

— He will. Just make sure you don't let me down. It's a very responsible job. Drop it, and it's prison.

The conversation ended, the guy (too bad I didn't remember his last name) walked around the hall, settled into the cabin, and waited.

Only certified people were allowed to assemble the product, and not only that, but also to manufacture it. The work was carried out under the control of the Quality Control Department and representatives of the customer (military). Each operation was described in a logbook. This was in case something happened, to quickly find out who did it and provide appropriate conclusions. But here — a guy from the outside, without instructions, without a non-disclosure agreement for state secrets, without certification...

In the office, on the table, were lists for bonuses for all participants in this epic. The experienced Yu.I. Lygin advised transferring the money to the expedition (to the cosmodrome) in advance.

— If it works out, you'll pay, and if not, they won't be lost, — he told me.

The lists were signed. The lead had already taken them to the expedition, and we went to the hotel to sleep. After all, our meeting was scheduled in three hours, and the plane to Moscow in eight. This was already December 30, 1982.

We woke up at 9 AM.

— You tell everyone that I signed the lists, warn them, and make sure everyone gets paid. It wouldn't be good if they thought the head of the main department was a chatterbox.

— Don't worry, everyone has already received it.

— How?!

— Immediately. Only those who just woke up are left.

He grunted with satisfaction. And everyone went to the meeting. The product lay majestically on the slipways and seemed ready for flight even tomorrow. Yes, such a rocket had not yet been seen at the test site. A small meeting gathered. The head of the main department and B.I. Gubanov spoke. They thanked everyone,

wished them a good holiday, and assured them that in the new year we would cope with all the tasks of the party and government.

The meeting ended. We went to lunch.

— You check that everything is normal, — the Chief instructed.

— Alright.

I went to the dining room early. They had already decided that we wouldn't have lunch, but would go straight to the airfield. My appearance was like a bolt from the blue. There was no talk of normal; they were just thinking about how to feed us. Our leaders arrived, lunch was sluggish, and there were only two bottles of vodka for everyone.

— I warned you. A simple matter! Now they'll think we're stingy, — the Chief reproached.

— We'll make up for it on the plane.

— Watch it!

I went to Leninsk. We shouldn't fall flat on our faces.

I filled two briefcases with cognac, figuring everyone would take some home, after all, it was New Year's! There was no time left for shopping.

We took off. This flight was remembered for a long time. We slowly started pouring. At first, there was a buzz, and the pouring continued, but by the middle of the journey, when more than half had been drunk, people began to spread out from the cabin into the seats and fall asleep. Fortunately, there was enough space on the plane. Twenty-seven of us were returning on the entire "Tu-134".

It's hard to remember how we got home. I just walked in, sat on a chair by the door, and slept for three hours. Those five sleepless nights and nervous tension took their toll.

Now we can argue whether this mock-up was needed or not. But back then, it was precisely it that gave a new impetus to everyone: to the factories, to the builders, to the installers, and to the testers. The first machine exists! And now it is being placed on the transport-installation unit and carefully, as if checking the quality of the road, the last meters of which the builders had made for Soviet Army Day, it moves along the path to the UKSS. The UKSS was not yet ready to receive the product, but the completed arrival did its job. Deputy Minister Sergey Sergeevich Vanin literally tore into both the builders and the suppliers' representatives during his operational meetings.

With us, he was extremely polite. Sometimes, with a sly look in his eyes, he would ask about our plans, how much time we needed to implement our ideas. Before the minister, he was responsible for preparing the ground equipment. And he simply needed to get his bearings in construction matters to pull up one section or another in

time. Having good connections, and simply friendly ones, with the command of the military builders, namely with K.M. Vertelov, he could quickly “close” problematic areas.

Military builders are simply legendary people. They worked wonders. Building with good finishing and elegance was beyond their power. But building strongly, reliably, as they say, for centuries — that was their style. If office finishing was required, civilians were always brought in.

Military builders carried out orders by any means, and if a concrete block was loaded onto a truck, the driver would deliver it to the construction site even on flat tires. Even if there were no headlights, the cab was broken, the body was warped, but if there was even the slightest possibility for such a vehicle to move, it would complete the task. Such vehicles posed a serious danger to others as well. After all, especially at night, one could easily crash into it, and the qualifications of young soldiers left much to be desired. It was not for nothing that it was said at the test site:

— A car in the hands of a military builder is a formidable weapon!

Once, I drove up to the “zero” pad of the UKSS and saw a completely incomprehensible picture. A young soldier was scraping the asphalt with a construction helmet.

— What are you doing?

— Sweeping.

— With a helmet?!

— There’s nothing else.

My surprise knew no bounds. I could imagine anything: a broom, a whisk, rags, bushes, but sweeping with a helmet?! Probably even the fantasist Jules Verne couldn’t have imagined that at the end of the 20th century, people would be sweeping with a helmet! The commanders’ imagination is great. The order must be carried out at any cost.

The product rolled along the rails, made a lot of noise, and returned to the MIC. Components from the Progress factory were arriving simply terribly. Spring had already taken its course, and we were treading water. Pipes, fittings, pneumatic shields were still undergoing development and fine-tuning in the metropolis. There’s nothing worse than waiting and catching up, — the proverb says.

The question was posed to the designers: what else could be checked or investigated on the full-size mock-up? They came up with an idea. Frequency characteristics could be measured. The plans provided for a full-size product and the construction of a full-size dynamic test stand at the test site. But the construction of the dynamic test stand (DTS) was delayed, so much so that even the

beginning was not visible. That's when the idea came to determine the amplitude-frequency characteristics of the rocket on the full-size mock-up.

What is that? Here's what. Imagine a product made of rubber, to one part of which a load is applied and then sharply removed. Due to its elasticity, the material transmits it, like waves, to all parts of the product. And the force comes, say, from the engines, also impulsively. It only outwardly seems that the processes of combustion and movement are stable. But in reality, everything shakes, vibrates, and all this is transmitted to the power structure. And it also vibrates, and God forbid resonance! That's a catastrophe. That's why both aircraft and rocket engineers so carefully study these oscillations and try to separate their natural frequencies from those acting on the structure. Our American colleagues, when creating their system, also studied amplitude characteristics, but on powerful stands.

So the idea came to conduct similar tests at the UKSS. Instead of one of the central engines, a force-loading unit was installed, and the "nose" of the oxidizer tank was gripped with a cable and tightened. A sharp release of the load allowed the sensors to record the oscillations. Processing the results was not a difficult task. The characteristics were determined quickly. Five tests needed to be conducted.

In the first quarter, finally, the first experimental rocket sample was ready for export. Only a decision on export needed to be issued. And then it began.

— You prepared the rocket. The decision is yours, — said the Chief.

And I "ran" through all instances. First in my own design bureau, then to subcontractors, and first and foremost to the organizations of V.P. Barmin and Yu.A. Karneev. I proved to everyone the necessity of conducting these tests. It moved forward with a creak. After all, for ground crews, accepting the product is not a simple matter when the installation of the UKSS systems is in full swing, and here a standard machine is standing. And if... and it went on. But with the help of the ministry, the industry was convinced.

I went to the military. And there was a wall! Everyone understood, but they wouldn't give their approval. You can't go without the military. After all, we work at the cosmodrome, and their order is necessary. Day after day, week after week passed, but there was no decision. I turned to the newly appointed minister O.D. Baklanov. I "caught" him at another launch of a manned spacecraft from the Baikonur Cosmodrome, along with the head of

the space forces command, General A.A. Maksimov.

The decision was approved, but the experienced Maksimov asked to add a small note: “The specific date for the product’s removal will be clarified additionally.” Well, that’s something! I fought and fought, and it seemed there was permission to remove it, and it seemed there wasn’t. Only later did I learn that D.F. Ustinov’s permission was required. No one wanted to take responsibility for showcasing a new product to the whole world. Why the whole world? Because by that time, national control means, or simply space intelligence, had progressed so much that car license plates on Earth could be seen on TV screens or in photographs from space. And to see a grandiose rocket — there was simply nothing to do here.

The intensity of the Cold War was still felt in the world. And here was a powerful rocket! A decision or approval from the very top was required. And now it was received! I am simply confident that this was O.D. Baklanov’s merit.

The pleasant news reached us on the eve of the May holidays. We decided to set the export date for May 7th. The commander of the 6th Directorate of the Cosmodrome, V.E. Gudilin, also had to cancel his regular vacation.

The rollout of the product, ever since Korolev’s time, was a solemn ritual. As a rule, all chief designers, commanders of units and directorates, the commander of the test site, and all representatives of higher organizations gathered for the rollout.

And so it was here. After receiving permission, S.S. Vanin, as chairman of the test commission, having heard about the readiness of the product and the UKSS systems for reception, scheduled the rollout for 6:00 AM local time.

By 6 o’clock, everyone had gathered in the fourth bay of the MIC. The product was placed on the transport-installation unit. Combat crews were formed. General V.E. Gudilin gave the final briefing. The command sounded: “Take your workstations.”

The 50-meter high gates of the MIC slowly opened. Fresh morning air rushed into the hall. Everyone went outside and watched as the railcars hooked up to the transport-installation unit.



V.E. Gudilin

A prolonged horn. And the massive installer with the rocket moved forward somewhat reluctantly.

The sun had just risen above the horizon and had not yet managed to eclipse the colors of the sky it had created with its rays.

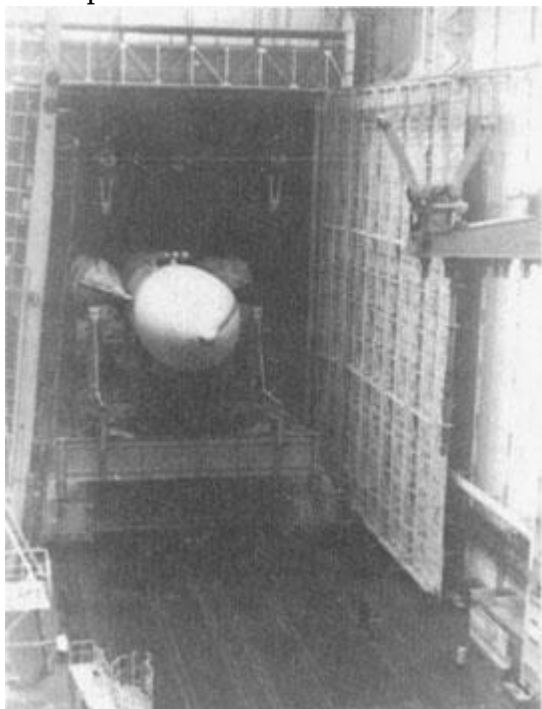
The railcars rolled out onto the front platform, rearranged themselves to the rear, and now everything was ready for the start of movement. The accompanying personnel climbed onto the front carriage. Slowly, as if afraid of shaking the product during the journey, the procession began its 15-kilometer journey.

Taking advantage of the procession's travel time, we went to breakfast, after which we immediately went to the UKSS to meet the product. We arrived half an hour before the installer. The testers felt nervous. The rocket was handed over to them according to the form.

Thousands of builders sat on the slopes of the gas exhaust trench, on the transition trusses, on the deflectors, and watched spellbound the new product — the rocket, for which they had toiled day and night, toiled in the dust, without enough sleep, working to their last strength. Practically, the builders had just removed the assembly cranes. And immediately, the rocket installation. How they wanted to see this rocket! After all, later, upon demobilization, they would proudly say that a piece of their labor was a contribution to this national program.

The nervousness of waiting and receiving the rocket passed, and the calm work of the crews began to lift and install the rocket on the UKSS launch device. The lift took almost a whole hour. The rocket was raised to a vertical position; it only remained to install it on the SPU (starting launch device). First installation! Will the attachment points coincide, will the bayonets enter block "Ya"? 20 mm remained. Our patience was running out. Together with Yu.A. Zhukov, the cosmodrome commander, we climbed onto the SPU.

We crawled along the joint, looking for gaps. Like a bolt from the blue, the command sounded: "Stop!" V.V. Lazarev and I were asked to approach the third plane. A little more and there would have been a collision of the rocket with a protrusion on the SPU. We lifted the rocket, removed the interfering protrusion, and the installation process proceeded as usual.



Rollout of the "Energia" launch vehicle on the transport-installation unit



"Energia" launch vehicle on the TUA near the UKSS

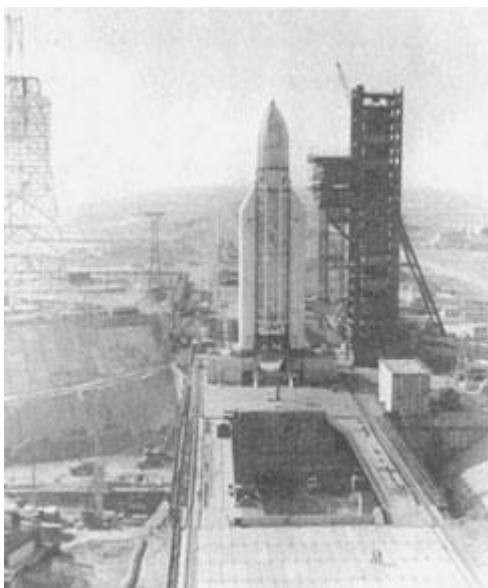
Another half hour passes and the command sounds: "Contact!" The docking nodes of the rocket and the UKSS on the plane, about 20 m, docked with millimeter precision.

Construction and installation work is still in full swing on

almost all UKSS systems, including the cryogenic complex, and the rocket stands majestically at the zero mark (this is the name of the place from which it starts). And as a reminder to you, the workers, it says: “Hurry up, because I’ve already arrived, it’s time for me to fly!”.



First installation of the launch vehicle (product 4M) on the UKSS



The first rollout of the “Energia” 4M launch vehicle to the UKSS took place before the completion of construction work

The safety zone around the rocket was fenced off, and the rest of the complex, having rested a little, began to live in its usual working rhythm.

V.P. Kuchinsky, modest, even, one might say, shy, responsible for the work at “zero,” undertakes the organization of these works. Laboratory vehicles, equipped with measuring equipment, arrived, and the testers began their tasks. Six tests for loading the tail section and four for loading the nose section needed to be conducted.

Everyone in Moscow monitored the progress of the tests: enterprises, the ministry, and the customer. General V.S. Patrushev presided on behalf of the customer, and General B.E. Aleskin on behalf of the ministry. They tried to understand everything and sometimes delved into purely technical aspects. At the moment of the pyrobolt firing, which sharply releases force, according to safety regulations, no people should be nearby. The first firing, the second, vigilance dulled, and then at the third firing, the generals, showing unnecessary heroism, remained in one of the SPU compartments.

The command was given to load the product, and suddenly we heard a strange sound, not like a pyrobolt firing. It turned out that the mounting bracket had broken off.

A.A. Makarov’s indignation knew no bounds when he learned that the generals were under the rocket during this emergency. The fact is that practically all rocket scientists are very superstitious people, and the slightest deviations from what is prescribed make them expect trouble. In all my time working in the rocket and space industry, I have never seen anyone raise a toast for future successes, or distribute bonuses or other rewards in advance, before a launch. That never happened. And the effect of the presence of superiors acted in the worst possible way.

That’s where San Sanych’s indignation came from.

— Get rid of these generals, — he told me, — they’ll ruin all the tests.

— Where?!

— I don’t know. Anywhere you want. Even take them to visit someone. But don’t let them appear at “zero.”

The idea was interesting. I consulted with our guys who lived permanently in the city. They lived amicably, like one big family. They shared everything together, both holidays and troubles. And there was no need to talk about helping each other. This small team of Yu.M. Danilov was the crystallization center for all of us, industrialists from NPO “Energia.” The family of Valera and Valentina Naumkin stood out especially. How happy they were when guests came to them! For them, it was truly a special holiday. Everything they had in terms of provisions ended up on the table. Such genuine joy was simply striking.

— Bring your generals. We’ll figure something out. Ours went

fishing, so there will be fried fish too.

I announced to the generals that it would take three or four days to fix the defect, and invited them to visit (the broken bracket was replaced in two hours).

This was a time when there was such a variety of alcoholic beverages in the city of Leninsk that I had not seen even in Moscow. More than twenty varieties of dry wines alone: Bulgarian, Romanian, and Hungarian. In the heat, dry wine diluted with boiled water particularly quenched thirst. So, we took a box of “dry” and went to visit.

Jokes, anecdotes, pranks, songs, and dances continued until morning. In the morning, a repeat, transitioning into the next day.

— I can’t anymore, — B.E. Aleskin complained, — take me to the hotel.

— Promise that you’ll come to the tests the day after tomorrow.

— Alright. But why?

— Well, we can’t stop them, and we can’t conduct them without you, — I cunningly said.

— I’ll come. Send a car.

Three days later, the tests were completed. And B.E. Aleskin, very pleased with the positive results, sincerely laughed at his isolation.

The test program for the first rocket rollout was completed. It was time to return to the MIC. Slowly and somewhat reluctantly, the installer removed the product from the launch device, and then a horn — the start of movement. We went home.

— Let’s go to my place, — A.A. Makarov invited.

— Let’s go.

— First job. Small, perhaps. But it’s already a reality.

— Yes, a reality, — I agreed. We went into the office.

— Bring us something, — San Sanych told A.M. Svinarev.

— I understand. Right away.



Employees of NIIskhimmash (A.A. Makarov, A.M. Svinarev, A.F. Vysotsky and others) at the UKSS

We approached the window. From the second floor, the picture looked more impressive. In the rays of the setting sun, in the haze after the midday heat (air temperature almost 30°C), two railcars pulled the spent rocket.

— Everything is ready, — said Svinarev.

We entered the office. The structure where we were located was temporary and subject to demolition after the completion of construction work. The main control point was still under construction, approximately 4 km away. The temporary structure had neither air conditioners nor refrigerators.

— Let's pour for the first tests, — San Sanych took a green bottle, removed the homemade cork, opened mineral water, poured from one, diluted from the second, and pushed everything towards me.

Having performed the same procedure, I raised my glass:

— To our success, with gratitude for the harmonious work.

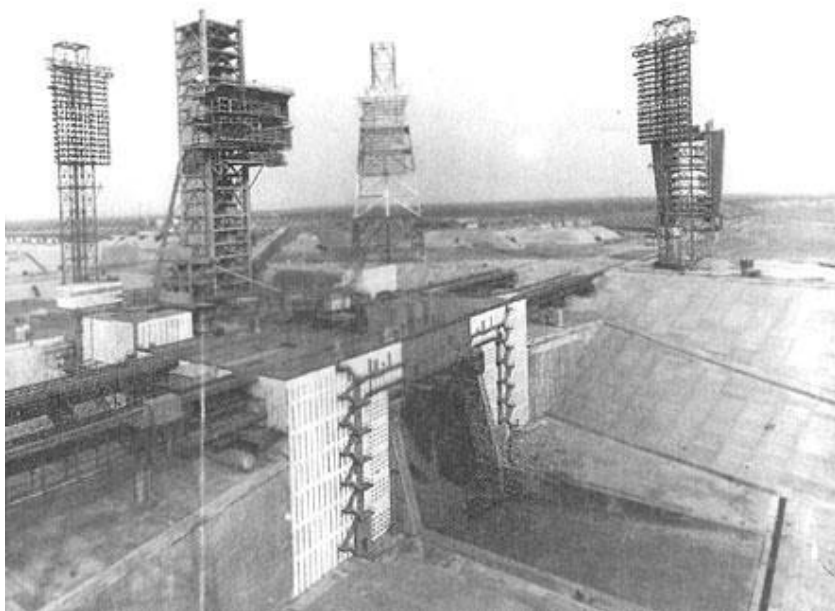
We drank this literally hot cocktail. Drank — that's a strong word, rather pushed it down. I noted that the snacks on the table were the most varied: mineral water, plain water. We washed it

down with warm mineral water.

It became somewhat sad. When would we arrive and meet next time? We didn't even imagine that we would meet at the UKSS in five months. The fact is that according to plans approved by high authorities, by the end of 1983, an act on the readiness of the first stage of the UKSS was supposed to appear. For this, it was necessary to conduct control tests of the UKSS systems and equipment directly interfaced with the rocket.

The rocket scientists resisted for a long time. After all, a trip to the stand stole a week from the assembly of the product itself, which was already behind schedule. But the persistence of Academician V.P. Barmin, his arguments convinced both B.I. Gubanov and V.P. Glushko that this trip was necessary.

On October 13 of the same year, we again arrived at the UKSS. The work was clearly organized. The day, as a rule, began with a morning operational meeting, which San Sanych Makarov conducted in the presence of Deputy Minister S.S. Vanin. He usually conducted them in a businesslike manner, after which everyone went to their workplaces. Representatives of the General Machine Building Design Bureau conducted author's supervision over all systems during the tests and promptly eliminated all emerging comments with their co-contractors. V.N. Klimov was responsible for them.



Universal complex stand-start ready for work

The creation of launch complexes and powerful stands for testing rocket systems is a huge range of technical and

organizational issues. After all, to create a complex in which about 250 different systems are united, for which, in addition to the launch device, it is necessary to build more than 150 structures, supplying them with energy, water, heat, sewerage, and to make all this work as a single, well-tuned mechanism — this is the hard work of many teams. And a special role in this is undoubtedly assigned to the general developer, which was the General Machine Building Design Bureau, and the general operating organization, which was NIikhimmash.

Undoubtedly and deservedly, each system of the stand requires a separate story, and one so wants to believe that the history of their creation will not sink into oblivion.

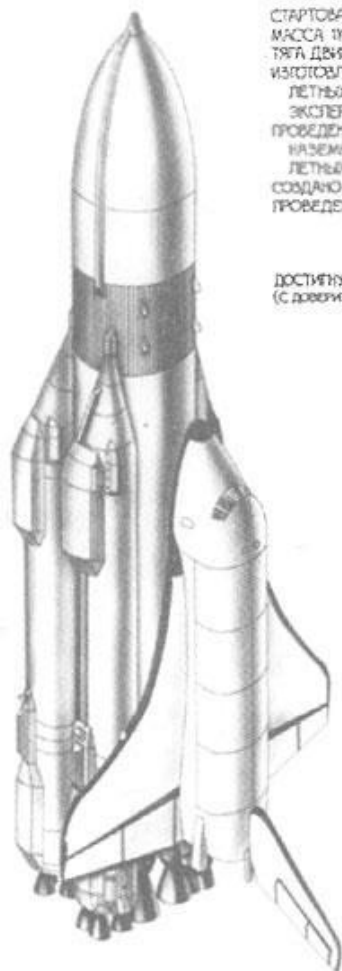
All possible tests of the complex with the product were carried out skillfully and technically competently. Acts were signed, reported to Moscow. Another plan for the teams was credited. We could leave the UKSS.

We returned to the MIC. And again, the established operational meetings began. They exhausted the foremen and designers. We really wanted to shorten this thorny path of production. The monotony with which the days passed caused irritation. The rocket scientists, accustomed to fast production rates, felt uneasy. After all, if you consider each detail separately, the simplicity of the forms was such that there were only two to four lines on the drawing (say, a pipe), but what labor it cost to manufacture it, and with high precision at that. And if you consider that there were hundreds of thousands of such parts and each required tens of man-hours, you can imagine how long the manufacturing dragged on. And if you also consider the unequal qualifications of the workers and production defects, it seemed that there would be no end to it.

TESTING GROUND

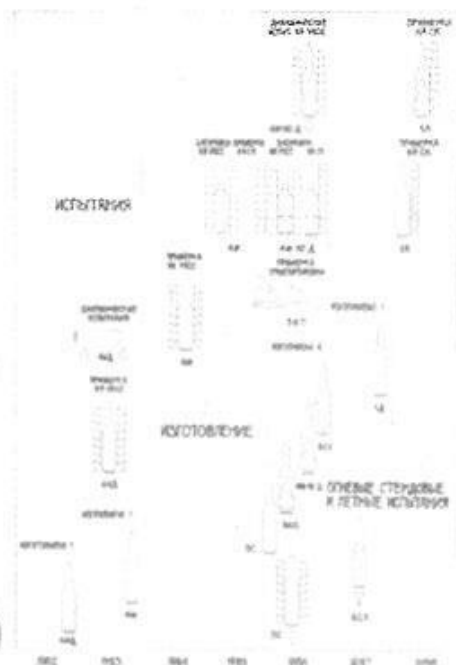
The year 1984 arrived, for which the first flight of the Buran reusable spacecraft was planned. But the first flight was elusive and so distant that even to us, the developers, it sometimes seemed like an unattainable dream.

What determines the success of the first flight of an airplane, a rocket, a spacecraft? One can say unequivocally—it depends on how well each system, assembly, unit, and part is tested on Earth, on the completeness of the testing. Designers and test engineers understand this well, but the leaders, from whom the state demanded: faster, faster, faster!—pretended that it was not their concern. Indeed, if something happened, they would hold the designer accountable for the failure. And if everything went well, they could share the rewards. The issue of product testing, despite its obviousness, required enormous persistence and perseverance from the designer in executing the planned schedules. They tried by all sorts of tricks and measures to preserve the original test plans. Special brigades and various commissions were created to review and approve test plans and their methodologies. In other words, everything was done to make it impossible to change the original plans. Nevertheless, deadlines, and again deadlines, for launch forced our ministerial leaders to periodically revise the scope of testing. If the engine plant stalled—let's reduce the number of engines being tested; if the plant manufacturing the control system stalled—let's reduce the number of test stands, and so on.

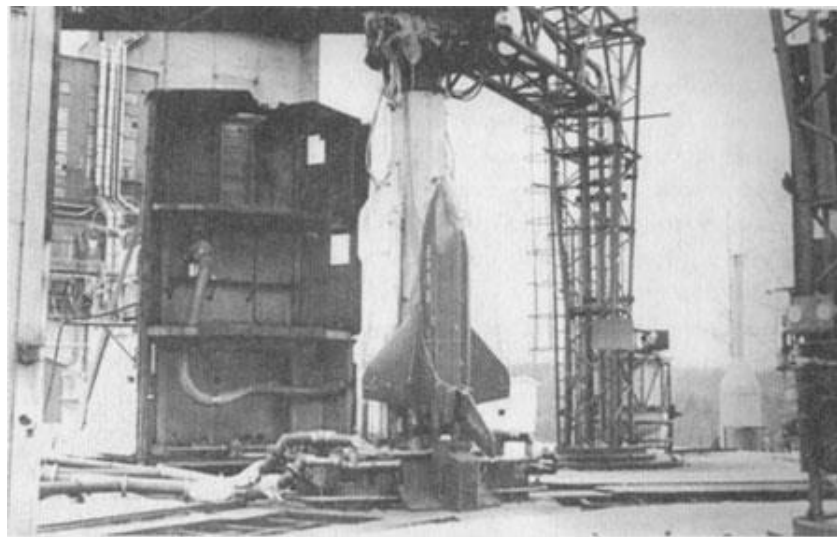


СТАРТОВАЯ МАССА, т	2358
МАССА ТРЭС Н ТЛ, т	90
ТЯГА ДВИГАТЕЛЕЙ НА ЗЕМЛЕ, тс	3550
ИЗГОТОВЛЕНО РАКЕТ-НОСИТЕЛЕЙ ТКЗС, шт	
ЛЕТНЫХ	2
ЭКСПЕРИМЕНТАЛЬНЫХ	5
ПРОВЕДЕНО ИСПЫТАНИЙ РАКЕТ-НОСИТЕЛЕЙ ТКЗС, шт	
НА ЗЕМНЫХ	5
ЛЕТНЫХ	1
СОЗДАНО ЭКСПЕРИМЕНТАЛЬНЫХ СТЕНДОВ, шт	168
ПРОВЕДЕНО ИСПЫТАНИЙ	341
	НА
	ЭКСПЕРИМЕНТАЛЬНЫХ СТЕНДАХ

ДОСТИГНУТАЯ НАДЕЖНОСТЬ РН ТКЗС К ЛЕТУ ТРЭС Н ТЛ 0,95
(с доверительной вероятностью $\beta = 0,9$)



Testing plan for the Energia launch vehicle for the first launch of the Buran orbital vehicle—



Experimental setup EU-360

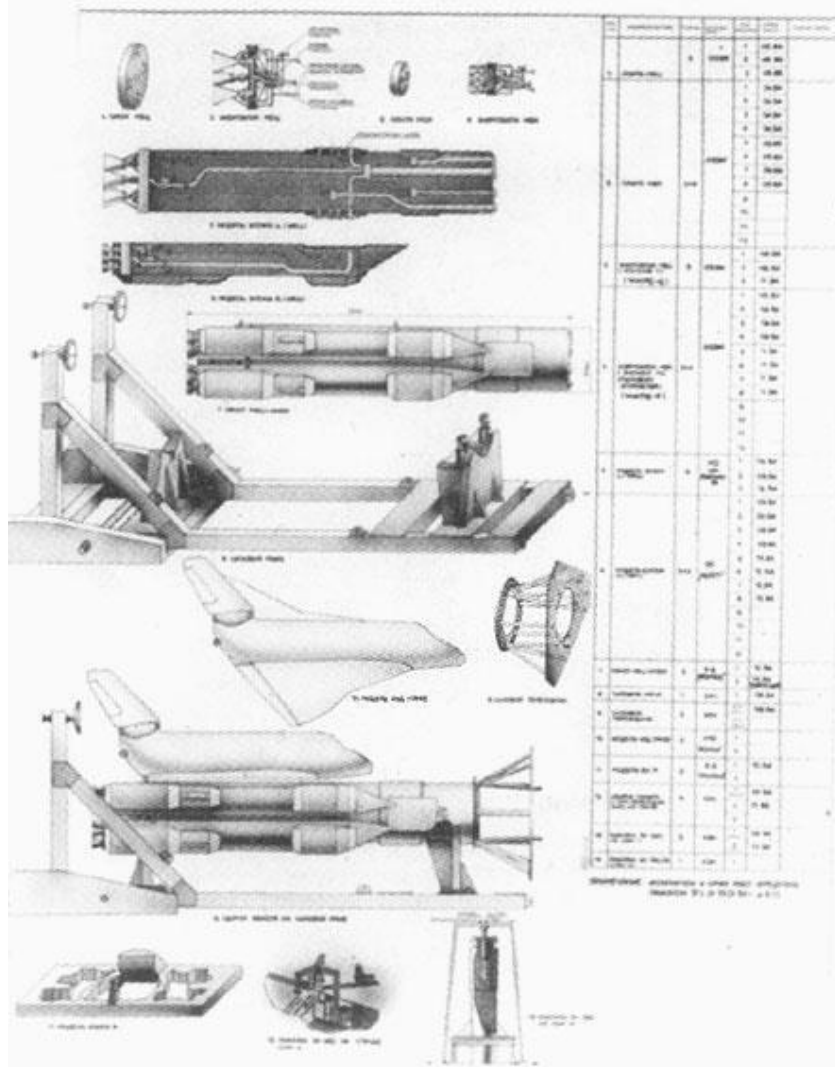
Sometimes, reductions were successful. But the designers were reluctant to agree to them and only after the most detailed analysis of tests already conducted.

The entire year 1984 can be called the year of the struggle for experimental testing. Our minister O.D. Baklanov understood this well. With an operational group of the interdepartmental expert commission, he traveled all over the country and demanded acceleration of the production of test stands. And yet, only about fifty of the largest ones were required. Zagorsk, Nizhny Salda, Kharkov, Primorsk, Omsk, Dnepropetrovsk, Leninsk, Khimki, Kaliningrad, Leningrad—this is an incomplete list of cities where they were created.

For such a large system as the Buran reusable spacecraft, for the rocket alone, it was necessary to test more than three hundred large full-scale installations, on which about seven thousand tests had to be conducted—and this is not to mention experimental installations of individual units, valves, aggregates, and systems. Not a single rivet, microchip, bracket, instrument, cable, aggregate, or system made it on board without undergoing experimental testing.

Undoubtedly, manufacturing such a volume of test objects (as we called them—hardware), and also the operational vehicle, was beyond the capabilities of the manufacturing plants, especially the lead plant “Progress.” Therefore, the designers divided the experimental testing into stages. The first stage included work on the first full-scale fueling article, the second—hot-fire stand tests, and the third—flight tests. I understand that for a wide range of readers this is not of particular interest—there was testing, and that

was it. But I think that our approach will help people involved with technology. And this is what I want to say about experimental testing: the paths to achieving the goal are so difficult, the problems of creating large complexes are so vast and diverse, that I want to draw the reader, if only for a few minutes, into that atmosphere of creation that is worth nostalgic memories.



Scheme for creating EU-360

The first and largest problem in the creation and testing of the Energia rocket was related to the extensive use of liquid hydrogen. In terms of its energy efficiency, hydrogen is superior to any conventional fuel, but its physical properties required very careful handling. These were, first and foremost, problems of hermeticity and thermal insulation. The overcoming of these problems has already been discussed.

According to the concept, elements of the reusable system, perhaps not all of them, should allow for multiple uses. Such was the launch-docking block, which we called the “Ya” block.

The constant dispute between rocket engineers and launch pad personnel: who is responsible for the rocket launch process—the rocket engineers or the ground crew? Suffice it to say that during the Energia launch in the initial period—at the moment of liftoff from the pad—about a hundred quick-disconnect couplings must operate: electrical, hydraulic, pneumatic.

If something happens, who is responsible? This question was acute during the development of all systems, especially when performing fast dynamic operations. The “Barmintsy” (Barmins’ people) absolutely did not want to participate in the process of separating the launch vehicle from the pad. The head of the General Machine-Building Design Bureau, V.P. Barmin, did not want to hear about it, citing many years of experience.

The rocket engineers had to introduce this cursed “Ya” block into the system. From the bottom, it was fully ready for automatic docking with ground systems, and from the top, it had breakaway pads that released the vehicle into flight.

Remaining at the launch site, this block was naturally exposed to the fiery jets of the launching rocket, which means that the block was subjected to significant pressure and high (thousands of degrees) temperature. The metal could not withstand it. It needed to be protected with thermal insulation.

It had to be created anew. The ZSP thermal insulation panels underwent more than one cycle of tests. And they enveloped the “Ya” block with their shell, preventing the hot rocket jets from penetrating inside.

Any aircraft must have a minimum weight, i.e., it is designed so that the chosen materials and structural forms provide maximum weight efficiency. And then the headache begins: will all this withstand, will it not fall apart?

For the developers, the most frightening questions were hermeticity and strength. Calculating the strength of a geometrically regular tank is not difficult, and the calculation of frame compartments has long been mastered. But when all sorts of flanges or holes appear on the tank in reinforced shells, our strength engineers feel uncomfortable. From the very beginning of the design, they lay down a certain amount of strength tests.

Our rocket was no exception. The scope of testing for strength characteristics was laid out in such a way that almost two sets of bodies had to be made. And the production capacities? They were only just being deployed at the factories. Again, it was necessary to

introduce stages and, first of all, check everything related to cold fueling operations.

The tank material was chosen for a long time and with difficulty. Television often shows how railway tracks shatter in severe frost. And here, the frost is an order of magnitude stronger. This means the material must possess both sufficient strength and elasticity. The newly created aluminum alloy 1201 satisfied all requirements, and in addition, it had an amazing property: at low hydrogen temperatures, it self-strengthened. Its strength characteristics improved by more than 5%. This meant a 5% gain in dry mass.

All this is true, but experimental confirmation was needed. So, a dozen full-scale assemblies are designed, test stands for them are created, and the work of many institutes and design bureaus is in full swing.

Material is material, but how to transform this material into the desired shapes, how to achieve complete hermeticity of containers? An even simpler question: how to connect individual shells and turn them into a container? After all, they need to be connected in such a way that there is both hermeticity and strength in the connection area. Welding was the best method. But existing welding methods were not suitable. We had to turn to the B. Paton Kyiv Institute of Welding. Thus, electron beam welding was born, which allowed forty-millimeter aluminum alloy sheets to be reliably joined with the required hermeticity. But all this needed to be tested. So, dozens of technological experimental installations are created, on which welding modes, the technology for manufacturing waffle shells, stamping with flanging, chemical milling of shells, bringing hatches "to condition," the technology for using ballistic adapters, checking hermetic plates, etc., etc., are worked out.

Tests of the full-scale article for static and cryogenic strength are first carried out on simulators, and then on the tanks themselves. The main lines are also checked for strength.

All this is typical for any rocket, but we have hydrogen! And on such a scale! What if it still spills?! Or starts slowly leaking into the body compartments? This question gave the designers no peace.

The ghost of H1 hovered in the air. So, our experienced designers came up with more than one way to prevent trouble. First, a special gas control system was installed on the product, which constantly determined the composition of the gas environment, and primarily the presence of hydrogen. Second, fire detectors were added to this system, which reacted to temperature and light in the compartments, including their local changes. And third, special cylinders with inert gas (nitrogen) were installed on

the product, which opened if an explosive environment was detected.

All these systems had to function according to a specific system and logic, and naturally, both individual sensors and the system as a whole, as well as the interaction of all systems, required thorough testing.

Unique test stands were built in Primorsk. Obsessed, indeed obsessed, and exceptionally decent people led by S.A. Afanasyev, under the ideological guidance of G.S. Potekhin, a representative of GIPKh, created experimental installations, developed hundreds of methodologies, and conducted hundreds of tests. It was they who gave this FEPPS (Fire and Explosion Prevention System) a start in life.

Cryogenic components, despite their high efficiency, cause considerable trouble for those who use them. After all, when they come into contact with “warm” metal, they boil, and gas bubbles can cause quite a few problems. Therefore, special installations are built to study the behavior of cryogenic liquids. Dozens of full-scale structures undergo spills. Are there any stagnant zones? Is the drainage even? Has everything drained from the tank? When does a funnel form in the tank? and so on, and so forth. The main tests were conducted at NIIkhimmash in Zagorsk. And now it seems everything has been worked out. The rocket can be transported to the UKSS and fueling operations can begin on the actual product.

FIRST REFUELING

On March 14, 1985, the product—our rocket—moved to the UKSS for the first stage of testing. A holiday for a rocket scientist. And on this day, it was double for us. The Chief's birthday.

We arrived. The rocket is installed on the launch device. A repeated check of the automatic docking of the product and launch devices takes place. All electrical, hydraulic, and pneumatic connectors are coupled.

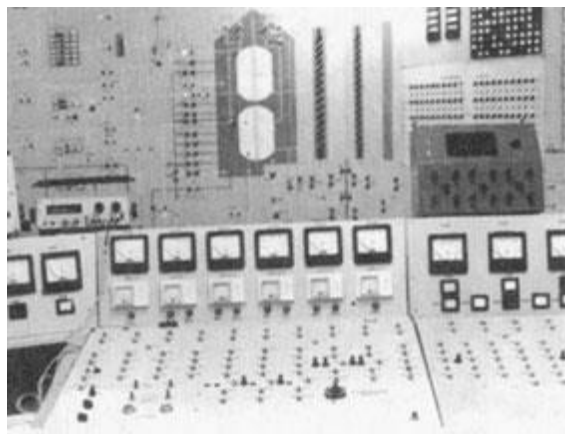
It was not without remarks. The electrical detachable connections "Butan" caused a lot of trouble. Everyone was used to the idea that if it's a connector, you just plug the fork into the socket and secure it, but here everything happens without human intervention, and up to 200 circuits are connected simultaneously, and if even one of the pins bends, trouble is inevitable. The entire "Butan" unit will have to be replaced. And this time we were unlucky. We had to replace it. But now all that is behind us, and we can proceed with the main work.

It somehow turns out that all our work stretched into the night. No matter when we started preparations, the critical operations always fell during nighttime hours.

That's it. The first is in place. The second is in place. Everything has been autonomously worked out, and now A.A. Makarov gives the go-ahead to start work with the product.

Inexperienced, thinking that the work had started and it was better for me not to interfere with the specialists, I got into the car and drove to my "deuce." I thought: I'll have dinner, rest a bit, and then come back.

I hadn't even entered the hotel when the attendant said:
—Makarov called, urgently asked you to come.



Operator-refueler's workstation

Something inside me sank. I ran out of the hotel, the car wasn't there. I grabbed the phone—no connection to the garage. Luckily, our test engineer with a car, returning from another "Soyuz" test, showed up. He gave me the car, and I sped to the UKSS. From a distance, I saw it: our dear rocket stood bathed in the searchlights. I started to calm down a bit. I entered the command post and immediately went into the control room. Two furious leaders stood glowering, arguing. One was A.A. Makarov, the other was the experienced test engineer Boris Arkadievich Dorofeev.

—Calm your people. I stopped the tests,—San Sanych said and left the room.

—What's the matter? What happened?—I asked B.A. Dorofeev. And this is what happened. Before filling the rocket's tank with hydrogen,

it needs to be prepared for this—its atmosphere must be replaced with a hydrogen one, otherwise the air in the tank will turn into liquid and ice. But first, the atmosphere must be replaced with nitrogen, and then with hydrogen.

This is the operation we were performing during the first test cycle. But during the nitrogen preparation, the ground systems began to create increased pressure on board. And the tank was overpressurized. And in such a situation, it could burst. Very calm and thoughtful work is needed. A quick analysis of the situation is needed. Every second counts.

Both San Sanych and Boris Arkadievich understood this well. Dorofeev, seeing that the pressure exceeded the permissible limit, yelled across the entire room:

—Stop! Cease the process.

He ran up to San Sanych, cursed him in the heat of the moment, and San Sanych cursed back. But the process was stopped, and they began to look for the culprit. That's when they called me,

as the conversation had gone too far.

I calmed them down as best I could. I separated them. It was already around two in the morning when the malfunctions in the system were found and eliminated.

—Go, get some rest,—I told San Sanych,—and you too, Boris Arkadievich.

They, already quite tired, agreed. I sat down next to the first crew member, A.F. Vysotsky:

—Listen, Sasha, do you know well how to proceed?

—Yes, seems fine,—he replied.

—Are the people in their places?

—Yes.

—Can you continue?

—Makarov told me not to.

—Under my responsibility. Let's move forward slowly.

—We can. Everything is calm now. Systems are normal.

—Well, then let's do it.

So, by A. Vysotsky's command, hydrogen first entered the product. This happened on April 18, 1985 (I didn't even remember my birthday). A businesslike silence fell. The tank was inflated with hydrogen. It was held. They began to vent. The gas analysis system cracked throughout the room. Hydrogen in the inter-tank and tail compartments. This was all we needed. We called our SPVPechnik specialists. They explained that the system could react to helium, which might be in the compartments when the valves activated. Gradually, everything quieted down. Again, nitrogen in the tank. Analysis showed that the hydrogen was completely displaced.

A.A. Makarov rushed into the room.

—Well, can we start?

—No, finish,—I replied.

—How?

—Like this. The hydrogen has already been expelled from the tank.

—Without me?—he was upset.—I only closed my eyes for a minute. Is everything alright?

—Everything is alright,—A.F. Vysotsky replied,—can I rest a bit?

—Go, thank you,—and San Sanych sat back in the first position, and there were still about five hours left until the end of the tests.

Everything ended well. A small “break” of three days, and then tests again. We spent a long time searching for the most reliable and safe solutions. How much we argued about first needing to fill at least 25% of the hydrogen volume. Everything would be calmer

that way. But the tank design didn't allow it. Something had to be figured out, and to avoid losing time, we decided for now to proceed with filling the tanks with liquid oxygen, but not yet to full volume. It was a bit scary. We agreed on a partial fill—450 tons.

One only needs to imagine again that people were fueling the product while being several kilometers away from the rocket. And this process was managed by a very intelligent automatic launch preparation system, for which we had to develop algorithms and control laws, meaning meticulous minds of mathematicians and programmers were required. This is where Professor Vladimir Mikhailovich Karashtin and his assistants: V.N. Bodunkov, I.V. Zemtsov, B.P. Rusakov, V.N. Ukhin, and many others, came in. Literally before the start of work, these voluminous albums and tapes were delivered from Moscow by plane.



At the meeting, A.A. Makarov, V.M. Filin

April 25, 1985. Fueling operations are scheduled by the minute. The first operations and commands begin at 9:00 AM. By 4:00 PM, oxygen should be on board. Should be, but it's not working out. Remarks follow remarks, and there's no end in sight. Will we really go into the night again?!

And so it happened. This is when you start to believe in superstitions and fate.

A month later—the second refueling. The tank was already fully pumped, which is about 600 tons of oxygen. The product handled such loads. Ten days passed, and the standard operating modes for the entire complex were being worked out. Tank thermoregulation was tested for the first time. The essence of this operation is that “cold” oxygen is supplied from the refueling equipment to the “warm” oxygen in the upper part of the tank, thereby averaging and lowering the temperature of the oxygen in the tank.

We completed the oxygen refueling, but the fear of hydrogen

never left us for a minute. We had gained experience with oxygen on other rockets. But hydrogen? There was no such experience in domestic practice.

And yet, they figured out how to refuel 25% liquid hydrogen. On June 18, 1985, 25 tons of liquid hydrogen entered the fuel tank.

The tension was terrible. I thought to myself: I'll have to go through this before every launch! After the first hydrogen refueling, we decided to give our nerves a small break. And the control "laws" for full hydrogen refueling were lagging.

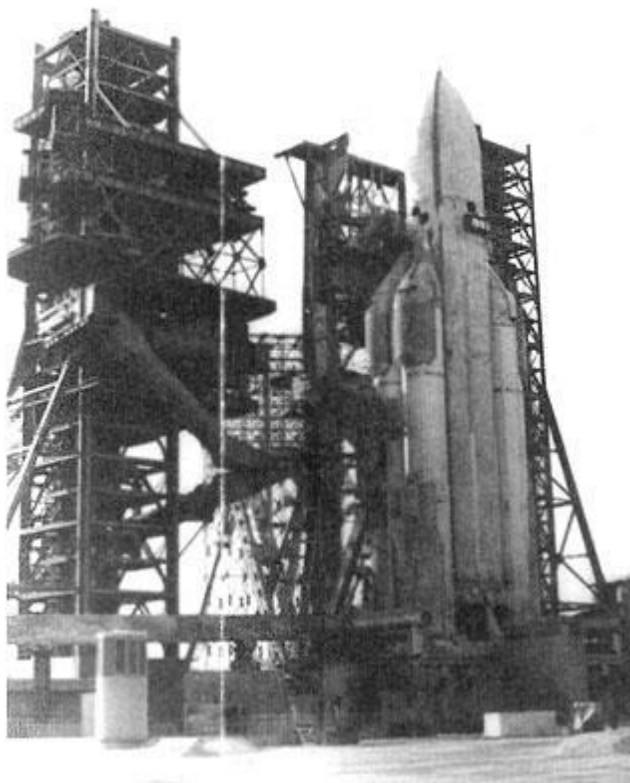
We once again worked through a full oxygen refueling, taking into account possible abnormal situations. Everything ended successfully.

Only in early August did we dare to proceed with a full hydrogen refueling. Again, tank preparation, again we went into the night. But the acquired, albeit small, experience with the product made itself felt. Everything went smoothly.

In September, we also completed the standard simultaneous refueling with oxygen and hydrogen.

We must give credit to our chemists. After each draining, they literally examined every centimeter of the tank's thermal insulation surface and repaired any questionable areas. It turned out that the thermal insulation behaved well when the tank was filled and full. But during draining, there were cases of delamination. That's why the chemists, led by A.N. Domoratsky, crawled over the tank like alpinists.

The last thing remained—to check the afterburning system for unreacted hydrogen emissions. As is known, the oxygen-hydrogen fuel pair is non-self-igniting. And until ignition, some hydrogen is ejected from the engine nozzles. The danger is well-known. That is why a special system was installed on board the rocket, which ignited these small amounts of hydrogen. Tongues of flame literally created a layer along the rocket, onto which the hydrogen fell.



Fitting of the “Energia” launch vehicle at the launch complex

We conducted two tests on product 4M. During the second one, already emboldened, A.A. Makarov and I drove up to the zero mark and observed the entire process up close.

How quickly these months flew by: it was already the end of September, and we arrived in March. We spent this whole hot summer at Baikonur.

We were home for only a few days a month. Now we can relax. After all, a lot has been done. Now all attention is on the next stage—the fire tests of the central block.

I flew to Moscow. The final disassembly work remained on the rocket. It was not without incident. During transportation, at a turn, the transport unit derailed. Unbelievable! All the ITD requirements went out the window. Oleg Sinitsa, who stayed behind as my lead, called me and reported what happened in a frightened voice.

The situation needed to be rectified. To put this unit, with a ninety-ton block laid on it, back on the rails.

Later, Oleg recounted how quickly the railway workers dealt with this task.

FINAL CHECKS

You go through the testing phase and then think, “What was so scary, anyway?” And all your anxieties and doubts before the tests seem trivial and childish.

But then a new stage begins, and again these “ifs” start... Any rocket rests on three main “pillars” — the body, the engine, and the control system. It must be said that the control system on the “Energia” rocket is an entire computer complex, consisting of six computing machines and many interface devices with other systems, such as gyro platforms, targeting systems, power supply systems, telemetry systems, etc. And all of this needs to be managed. This means mathematical programming is necessary.

Hundreds of mathematicians from Kharkiv developed these ill-fated programs at the NPO “Hartron” firm. The firm was headed by V.G. Sergeev, but the “motor” of all developments was, undoubtedly, Ya.E. Aizenberg. He later became the head of this firm. Mathematics is theory, but the embodiment and implementation of the entire program lay, undoubtedly, in the devices. And again, the responsibility for their timely delivery fell on the Kharkiv residents. A.S. Gonchar was responsible for them. He was the “scapegoat” at all MVKS (Interdepartmental Commissions) and so on.



КОЛИЧЕСТВО ВОЗГОНОВ ЦДМ 12
 КОЛИЧЕСТВО ПРОСТАВЛЯЕМЫХ ПОДГОНОМ 3
 ПРОХОДИТЕЛЬНОСТЬ КОМПЛЕКТА ВОЗГОНОВ ЦДМ 1 млн 700 тыс.
 КОЛИЧЕСТВО ВОЗГОНОВ ВОЗГОНОВ ЦДМ 200 тыс. для монтажа и демонтажа
 КОЛИЧЕСТВО ВОЗГОНОВ ВОЗГОНОВ ЦДМ 2,5 млн для монтажа и демонтажа
 КОЛИЧЕСТВО КОМПЛЕКТОВ ДЛЯ БЛОКА А 17
 КОЛИЧЕСТВО КОМПЛЕКТОВ ДЛЯ БЛОКА Ц 4
 СОЗДАНО ОТРАБОТКА СТЕНДОВ 16
 ПРОЦЕСС ИСПЫТАНИЙ СДЕЛАННЫХ, АЛГОРИТМОВ, КОМПЛЕКТОВ 50
 ПРОЦЕСС ИСПЫТАНИЙ В СВОЕ ВРЕМЯ ИСПЫТАНИЙ БЛОКА НАДЕЖНОСТЬ 6
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АВТОНОМНЫЕ И КОМПЛЕКСНЫЕ ИСПЫТАНИЯ

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ПРИЕМО-ДАЮЩИЕ ИСПЫТАНИЕ АППАРАТУРЫ

СТЕНДЫ ДЛЯ НАЗЕМНОЙ АППАРАТУРЫ

СТЕНДЫ ДЛЯ РАКЕТЫ-НОСИТЕЛЯ ПРБЗ

СТЕНДЫ ДЛЯ БЛОКА А

СТЕНДЫ ДЛЯ БЛОКА Ц

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7000 40-40 60Л 10 20

1983 1984 1985 1986

Plan for the development of the autonomous control complex for the “Energia” launch vehicle

The complex control system required development of both the hardware and the mathematics. Special stands with executive power elements were built in Kharkiv. These were mainly the steering machines of the propulsion units.

Our curators, E.F. Kozhevnikov and P.F. Kulish, also had their share of difficulties. After all, they had to be provided with the necessary initial data on all rocket systems.

The Kharkiv residents were terribly behind schedule. It was a good thing their system did not participate in the hot-fire tests.

However, the engines of the central block — block C — took direct part in the hot-fire tests. After all, the main task of hot-fire tests is to teach and verify the interaction between the rocket’s propulsion system and the engines. Many do not fully understand this terminology. What is meant by a propulsion system? These are the rocket systems that ensure the engine’s operation, primarily: the

fuel supply system, the tank pressurization system, the fueling control system, the tank oscillation damping system, and inlet pressures, etc. This is what we called the propulsion system. This is precisely why hot-fire tests of rocket blocks are conducted, to “link” the engine’s operation with all supporting systems.



Plan for the development of the second stage block of the “Energia” launch vehicle

And again, safety issues were paramount. One thing was pressing — the expensive orbital spacecraft could not be lost during launch.

So the designers included two stand-alone articles, which they called 5S and 6S, in the comprehensive experimental development program.

The total number of firings was determined to be 17, and the total operating time was 3700 s (the flight time of the central block was about 600 s).

How many tons of fuel — liquid oxygen and liquid hydrogen —

The hot-fire test was prepared for thoroughly and meticulously. The engines had already accumulated their service life on test stands in Nizhny Salda. The design and the embedded solutions were verified. They could be supplied for assembly into the rocket. For this purpose, according to a pre-established methodology, each engine, before being installed on the article, was sent to a test stand. The requirement was that an engine should complete one service life on the stand, one during hot-fire tests with the article, and another service life — residual — was reserved. The Voronezh residents put a lot of effort into achieving such service life levels. I think their chief designer, V.S. Rachuk, spent many sleepless nights. The problem of creating the turbine alone took so much nerve and energy that only those who believed in success could endure it. The turbine speeds were such that the metal could not withstand the centrifugal forces and disintegrated. The search was persistent. A method for manufacturing the ill-fated turbines was found: powder metallurgy came to the rescue. If we talk about engine specialists, it can be said that ever since their student years, they always considered themselves intellectually superior to other students.

“If you have a good engine, you can teach even hangar doors to fly.” This is how they always cited A.N. Tupolev’s famous saying. And our General, V.P. Glushko, in his narratives, said much the same thing. He began to specialize in engine development precisely because there are many more problems in an engine than in any other rocket system, not to mention the body. He was confident in this and therefore considered it his duty to tackle this most difficult area in rocketry.

Undoubtedly, creating a rocket engine is no easy task. It is no coincidence that in our country and throughout the world there are special design bureaus that deal only with engine creation. This applies to aviation and automotive engineering, and rocket technology is no exception.



Vladimir Sergeevich Rachuk

As a rule, these design bureaus develop a variety of engines, but they still have a main focus based on engine type. In the 1970s, the Chemical Automation Design Bureau (Voronezh) was engaged in hydrogen main engines. The General Designer of the Design Bureau, A.D. Konopatov, entrusted the leadership of our direction to the young Candidate of Technical Sciences, Vladimir Sergeevich Rachuk, appointing him Chief Designer of the “Energia” rocket’s main hydrogen engine. The General was responsible for making decisions on fundamental issues, while all the “routine work” fell to Vladimir Sergeevich.

The path of engine creation is thorny. The example of the turbine can give a small idea of this. But that is a major problem. And how many smaller ones are there? To avoid them, a whole series of research and tests are thought out, various stands are built for testing individual units, and finally, the engine goes to the hot-fire test stand. Here, its refinement to the required parameters for survivability, reliability, and safety begins.

One of the tasks set before the Voronezh residents was to create an engine whose characteristics would not be inferior to the SSME engine of approximately the same size (thrust of about 200 tf) created within the American Space Shuttle program. Engine development was difficult. It was necessary to explain the reasons at the MVKS meetings, report on the measures taken, and ask for help.

Credit must be given to V.S. Rachuk, who did not dissemble or prevaricate in his reports, but honestly explained what and why he was failing to achieve. He never blamed others, but on the contrary, admitted his own shortcomings and mistakes and spoke about how he intended to correct them. I never heard him make unflattering remarks about management or colleagues. He seemed like a gentle

and kind person, but that was only in everyday life; regarding the engine, his position was extremely clear, and if a decision was made, he became firm and stubborn in implementing it. I remember him, and immediately several other images of middle managers and engineers come to mind, for whom technology was an idol and who were ready to work day and night (which they did when necessary), just so their product would be the most perfect. Among them, we can name Sokolov B.A., Khaspekov V.G., Lyfar V.S., Alexandrov G.Ya., Takhtasyeva A.D., Lukyanova E.A. — and this is just among the engine specialists.

I've gotten a little carried away with engines. This area, of course, deserves a separate narrative. There's only one problem. Starting from our student years, we were accustomed to the secrecy of the work performed. Making any notes on unrecorded sheets of paper was strictly forbidden. This meant disclosing state secrets with corresponding consequences. That's why so little has been published and popularly written about our industry. Perhaps I am wrong in my reasoning, because B.E. Chertok's book "Rockets and People" did appear, where events are described in detail, precise dates are given, characteristics of people are provided, and their names and patronymics are mentioned. This probably cannot be done from memory.

And yet, I cannot help but mention one more peculiarity of these people — the engine specialists. It's their way of life. Each expedition to Baikonur had its own base. The Voronezh residents also had a base. Once, as the workday was coming to an end, Volodya Rachuk approached me:

- Don't you want to go to the banya (bathhouse)?
- Which banya?
- To ours.
- What do you mean "to ours"?
- To our cottage at site 95. I'll call now, they'll prepare it.
- What should I bring?
- Nothing.
- And a bottle?
- You're offending me.
- Alright. When?
- Around seven. Your transport.
- Understood.

It never occurred to me that there was a banya in a cottage at the test site, where water was scarce. I knew there was a public banya at site 10 (Leninsk), and even that operated intermittently, but here, at the site, and at one of the distant ones at that? Miracles!

We went. We entered the cottage. The host greeted us very warmly. And led us through the yard to R.F. Ignatusha's establishment. That's what he called this place. R.F. Ignatusha was A.D. Konopatov's deputy for testing. His duties at the test site included technical supervision of the testing of serial engines installed on operational rockets. One such rocket was the "Soyuz."

He spent a significant part of his time at the test site. And with the help of test engineers, he built this establishment with his own hands. The banya was small, heated with firewood, which was delivered from Voronezh by passing transport. Birch firewood was preferred.

Dry sauna. Shower with cold and hot water. A lounge and a billiard room.

— A good establishment, I said.

— We try, Volodya replied.

While we were steaming, the lounge transformed. Steaming Voronezh potatoes, cucumbers, tomatoes, greens, salo (cured pork fat), and something else appeared on the table. And of course, alcoholic beverages, also of Voronezh production.

— You know, tea would be better.

— I'm not a good drinker, Volodya said, — you're right, tea is better.

Volodya had recently undergone a serious operation, and doctors had advised him to restrain himself in such situations. Nevertheless, we had a shot, a snack, and went to play billiards. The table was very good, the pockets were not broken, so with our playing skills, we never finished the game. We drank excellent tea and returned home late in the evening. I still fondly remember that evening. Later there were many bathhouses, but this first one stayed in my memory for a long time. I thanked Volodya with great pleasure for the enjoyment he provided.

The delivery of engines to the test stand machine was not the "last resort." Again, we were tormented by pipes, by welding joints. A special pipe section was organized in an annex of the MIC in a special workshop.

Our ministry also underwent a transformation. A special main directorate was organized for the "Energia-Buran" project. P.N. Potekhin was appointed its head, and B.D. Ostroumov became the chief engineer. To strengthen control, the minister sent his deputy, A.I. Dunaev (future director of Glavkosmos), to the test site.

O.N. Shishkin — the deputy minister responsible for our direction — went to the "Progress" plant, accompanied by A.E. Shestakov — the commander of the technological main directorate. The situation was escalating more and more. Virtually all factories

in the industry were involved in manufacturing pipelines, pneumatic panels, and other rocket components. As they say, the locomotive started to roll. The assembly of the product was slow. According to the documentation, it was necessary to manufacture pipe standards, which would then be used to produce pipelines for subsequent products. This further slowed down the production rhythm.

A.I. Dunaev was very burdened at the test site and finally asked the minister for leave. The chief engineer of the main directorate, B.D. Ostroumov, was sent. We knew each other from the time I worked on the orbital spacecraft. Again, operational meetings, reports to the metropolis. Boris tried not to interfere with the production workers, organized help when he was approached, and the help was indeed effective. He developed friendly relations with everyone; he never showed that he was the boss, but tried to convince them of the necessity of doing one thing or another.

SECOND DIGRESSION

Sometimes we wonder why we were taught in school according to a single union program, why everyone was a pioneer, a Komsomol member. It was believed that everyone should be able to do what others could do. We were all equal. But everyone felt within themselves that this was not true. When they said that some had a musical ear and others did not, it was understandable. But everyone was supposed to be able to write an article or organize some event or something similar. True, this is no longer the case. The world has divided into capable and incapable, intelligent and unintelligent, proactive and unproactive, and mostly average people, but each person is an individual, and what one can do, another cannot, and vice versa.

In my distant childhood, my grandfather told me:

— If you take on a task, do it in such a way that you yourself like it. Let it be your handwriting in a letter, or a planed handle for a shovel, or something else. Do it well, and then you will see that others will like it.

My upbringing, which my parents continued, only reinforced this instruction. “Whatever you do, when you interact with people, or whatever you do for others, big or small, first think: will they enjoy this? Always put yourself in their shoes in such cases,” they would say.

How much our society lacks these principles now! Following my parents’ advice, I often analyze past events and draw certain conclusions. Their advice and the logic built upon it often helped me out. But I wanted to talk about how conclusions from the same events can be completely different, and based on the analysis, the foresight of future events will also be different. This is what I encountered when I started communicating frequently with Boris Ostroumov.



Boris Dmitrievich Ostroumov

He had his own logic, and it must be said that in past events he saw more than I did (I mean the volume and quality of information), hence his conclusions and foresight of future events were different and, of course, more realistic and correct. He believed in the “Energia-Buran” project infinitely, not allowing himself or others to doubt it. Being also the secretary of the MVKS, and then the secretary of the state commission, his formulations in the decision defined such an order of execution that for a leader to “fail” on an issue was tantamount to losing their job. Fierce disputes flared up at meetings, and he quietly sat aside, and as soon as a speaker finished, he would send his formulation on the matter to the minister. It would be read out and, as a rule, immediately adopted. We also received assignments at such high-level meetings. Sometimes, as they say, our heads would spin: where to start the execution?

— Oh, stop being nervous,— he would say — I’ll help.

And indeed, within 5 minutes he would sketch out the “framework” of the document, which only needed to be supplemented with individual facts and formalized.

Whenever I visited him, he was always reading something. Possessing a good memory, he often quoted authors in his statements.

I saw him in many situations. But I practically don’t remember him losing his temper, yelling at someone, or offending anyone. Life presented him with the heaviest grief: he lost his friend and dear person — his wife. For several years he fought for her life. But no one ever saw this affect his professional relationships with friends. One must have a very strong character to endure all this. An analytical mind, honesty, conscientiousness, the ability to cherish and maintain friendship — these, in short, are his traits. It’s a pity that such characters are not often met in life. But I was lucky.

CLOSER TO THE FIRE

One of the memorable events at the testing ground was the arrival of P.N. Potekhin—our chief director. He was the one who started the tradition of continuous presence at Baikonur of a ministry head responsible for a specific product. The minister entrusted him with assembling product 5C by the November holidays of 1985.

He was already a boss. He started giving instructions to everyone. Having come from the technologists and understanding the matter well, he essentially replaced the director of the Progress plant branch, N.S. Shurakov. He organized a dispatch service at the branch and constant communication. He knew exactly when and which part would arrive from Kuibyshev for assembly. He studied all the pipelines. He knew the number of each pipe and the system it belonged to.

—Where are you taking the pipe?—he asked a worker carrying a pipeline from the tail section assembly stand.

—What do you mean “where”? To passivation.

Pavel Nikitovich looked at his notes.

—What’s the pipeline number?

The worker named it, and then, like a bolt from the blue:

—You’re fired! Take it to the tail and install it. It has already passed everything; its place is in assembly.

The threat of dismissal was real. Perhaps not dismissal itself (that was the prerogative of the director and the trade union committee), but a transfer to another job was a reality. And that meant a loss of earnings. After all, pipefitters earned three to four times more than engineers on assembly. Many came to the branch specifically for the earnings. Working as a family, they could very quickly buy both a personal car and a cooperative apartment. It should be added that good travel allowances were added to the salary, and the coefficient for special and weather conditions was 1.5. The hegemon knew his business well and sometimes did not rush with the assembly. He understood well that the next push would only increase his salary. And the end of rush jobs meant the end of big earnings.

They arranged their lives, or rather their leisure, themselves. Having received a land allotment on the banks of the Syr Darya, they organized a recreation center. Using sections from the N1 “Tsar-rocket,” they built pavilions, rest rooms, gazebos, changing rooms, and dug a pit for an artificial lake. Water was supplied by

pumps from the Syr Darya. It gushed out in powerful streams from a fountain created by skilled hands and filled the lake by gravity. You drive up to the base, and a kilometer away you can see the fountain's streams. This meant that the water level in the lake had "dropped" due to the heat and it was being refilled.

The engineers of our branch also kept up with the hegemon. Not far from the fountain, they built a small house with about ten rooms and a large veranda. The keeper of this place was Egorych. That's what everyone called Nikolai Egorovich Shashin. He was alone. We didn't ask about his fate. We considered it impolite. Perhaps something broke in his life, and he retreated into solitude. He lived in this building all year round. He went to buy groceries at the nearest station, Dyurmen-Tyube, and sometimes even reached the city by bicycle over the ice. In winter, the house was heated by electric batteries, and when the cable was damaged, which happened quite often, Egorych would crawl under several mattresses and warm himself only with his own body heat. He had to walk about three kilometers to the backup control point for water. Summer was a little easier. After all, every Friday, Saturday, and Sunday he had vacationers. Fishing provided him with some food, but there was never a time when we visited that he didn't treat us to fish soup. The shashliks we brought were also good, but Egorych's fish soup was a hundred times better. And the tea made from camel thorn, which, according to Egorych, was the most medicinal!

Once, the chief designer of the Volga branch, B.G. Penzin, came to the testing ground and said that P.I. Kirsanov was leaving for Kuibyshev and G.G. Romanov would remain in his place. We were introduced. I immediately took a liking to him. A strong, healthy man from the Volga region with a kind smile on his face made the impression of a balanced and confident person. Later, I became convinced that this was indeed the case. All design support for the manufacture of the central rocket block was his responsibility. He had several departments, both design and testing. The total number of employees reached two hundred people. To manage such a team, the leader himself needed sufficient competence. Gennady grew literally before our eyes. Now it seems that not even a month passed before he solved all complex issues regarding both design documentation and production. Although his entry into the new position was smooth, and P.I. Kirsanov helped him a lot.

The position of Deputy Chief Designer for production support is terribly restless. If anything happens in production—a pipe is hit, a dent in the bellows, or something else—they wake you up in the middle of the night: write a note stating that it's permissible. In

such situations, one needs not only a strong character but also sufficient technical erudition to make the right decision. After all, the final word was always his, Gennady's. He brilliantly navigated these tricky situations, never doing anything to the detriment of reliability. I worked with him in tandem for a long time, and I was always calm when Gennady was around.

He was not ashamed, if a question was too complex for him, to turn to me or to the Chief, and this only enhanced his positive traits. There were cases when a worker made a mistake, a deviation from the requirements of the design documentation, which meant a defect, writing off costs to the plant, and loss of earnings for workers and foremen. So they would run after the designer to issue a "notification for rework" instead of the technologists issuing a "resolution card." In the first case, the fault lay with the designer, and since these were experimental works and "bribes were smooth"—no one suffered. In the other case, the fault was with the plant. So a tug-of-war ensued. And here G.G. Romanov acted very reasonably. He understood when he could meet production halfway and when he could not. He managed to see the fruits of his labor: both the first launch of "Energia" and the second. Then fate decreed otherwise. He died at the peak of his creative powers, leaving behind the brightest memory of himself.

Work on the projects continued day and night. The assembly of the tail section was now complete, and it was time to connect it to the hydrogen tank. The oxidizer tank was already docked with the inter-tank section. Further assembly of the central block proceeded more easily. Many did not believe in the success of our endeavor to create the Energia-Buran system. And it was especially offensive when our own leaders, who were working on other topics, did not believe.

One incident stuck with me for a long time. Two teams from our organization gathered at the testing ground. One was preparing for the launch of the Mir station, the other for the Buran orbital complex. It must be said that the people testing the station worked just as hard as ours. But all the work was carried out pompously. The deadlines for creation were set at one year from the date of the Central Committee and Council of Ministers Resolution. So my colleagues had a tough time, as they had to work around the clock, and also with military testers. And they honorably completed the assigned task. A year and 1.5 months later, specifically on February 20, 1986, the Mir station was launched into orbit.

But I am talking about the autumn of 1985, when the Mir station tests were in full swing. I was returning from work, driving up to the hotel. Testers, as we called them, working on the manned

program, were sitting on benches at the entrance. At that time, one “Buran man” lived in this hotel. The evening was unusually warm and mild, even without mosquitoes. Such evenings are quite rare for Baikonur. So our guys went out to sit on the bench and chat.

I greeted them and walked past. And suddenly, one of our leaders, sprawling casually on the bench, asked:

—So, how are things with you?

—They’re going slowly. We’ve connected the sections.

—And do you think anyone needs your theatrical prop?

—What?! And you’re telling me this in front of everyone?—I somehow involuntarily switched to “you” (informal).—How can you say this in front of everyone? If you don’t believe, why are you in charge?

I literally flew into a rage:

—You know very well how all this is created. You visited the facilities, you saw how officers at the landing complex live with their wives and children in plywood houses. Their children have inflamed eyes from the sand and dust. Sometimes they go without water for three days. You saw all this. How can you offend them and how can you work with us without believing in the project?

His casualness vanished; he tensed up. Clearly, he felt uncomfortable in front of the employees.

—I’ll have to report this to Glushko,—I concluded and quickly entered the hotel, noticing how pale he had become.

The next morning, I came to the office, again the usual routine. But already, a light was visible at the end of what seemed like an endless tunnel.¹³²

V.M. Filin. “THE PATH TO ENERGIA”

Around 9 AM Moscow time, 11 AM local time, the Chief called:

—What’s going on with...?

—Nothing special.

—Don’t get agitated. I’ll be there soon, we’ll sort it out.

—I’m not going to. It’s just upsetting.

—It’s okay, just bear with it.

As it turned out later, after I went to my room, this leader contacted his Chief via long-distance communication. Apparently, my monologue had an effect, and his fright was serious.

—A nasty incident happened here, calm Slavka down before he does anything foolish,—he pleaded over the phone.

Upon the Chief’s arrival, the three of us gathered.

—I apologize. I was just joking.

—I don’t understand or accept such jokes.

—Alright,—said the Chief,—we consider the incident closed.

A lot of time has passed, but this has stayed with me for life. I

can understand being personally offended, but when my work, my comrades, are offended, a protest, like an explosive wave, erupts from within, and sometimes I want to, without restraint, punch the offender in the face.

The central block is assembled. It is necessary to move the machine to the adjacent bay and place it on the KIS, i.e., to carry out its inspection at the control and testing station.

We immediately remembered the ill-fated railway unit specially manufactured for these purposes. Having a small base (standard railway gauge), due to wind loads, it could not only derail but also simply overturn. What to do?

—I think we can use the self-propelled unit, which is designed to deliver sections from the landing complex to the MIC,—G.Ya. Sonis proposed.

—What is it designed for?—asked the Chief.

—For transporting 50 tons.

—And what is our actual weight now?

—I think, 80-90 tons.

—Let's try, but precautions are necessary, we cannot risk it.

—One of the measures is to weld limiting posts at the corners of the transport frame. The platform is flat, we don't need fasteners, and we are insured against overturning.

—Agreed,—Boris Ivanovich replied.

The posts were surprisingly quickly manufactured, and even made adjustable, and welded to the transporter. The 60-meter central block was carefully reloaded. Evening came. The sixty-meter-high gates opened. A "Uragan" tractor, roaring with its powerful engine, drove into the hall. Many had seen them on television. They are the ones that transport mobile missile systems.

The transporter was hooked up. We could move. Grigory Yakovlevich approached the Chief.

—Boris Ivanovich, I ask you to sign the logbook for the transportation. I have signed it, but I want you to sign it too.

—Where is the logbook?

—With me.

—Give it here. We'll be responsible together.

The Chief understood all the safety margins that the ground crew incorporated, took a pen, and affixed the chief technologist's signature. Sonis breathed a sigh of relief and gave the command to start moving.

Slowly, we moved out of the MIC. Outside, the night had scattered its celestial patterns. It was cold. The breeze wasn't strong, but it chilled to the bone. We couldn't stand it, so we got into the car and watched the procession through the windows. A worker

walked at each corner of the transport frame, ready to extend the safety support if necessary. This operation lasted for over an hour. It seemed like an eternity had passed. But here we were in the fourth bay, which greeted us with lights and a thermal curtain. Further on, it was the usual crane operations. The “supports”—that’s what we called the power mock-ups of the side boosters—were in place. The schedule was also prepared: assemble the package in ten days.

Many other small and large nuances, both technical and organizational, had to be overcome. But on the eve of the long-awaited event—fire tests—everyone felt uplifted. Everyone tried to help with advice, offered themselves to perform one task or another—just to make things move faster. Somehow, the new year 1986 crept up unexpectedly. The Minister allowed everyone to celebrate it at home with their families. There was a certain lull during the New Year holidays. But by January 4, everyone was back, and the tests of the already assembled package began in full swing.

January 23—final report to the technical management, and the go-ahead is given to transport the rocket to the UKSS. Everything happens as usual, in the traditions of Baikonur. Again, everyone gathered in front of the gates, seeing off the product, which had become painfully close, on this difficult journey. How will it behave during testing? Will it return to its home? Doubts gnaw at everyone, what if... We understood that everything that had been done and tested must work. It must! And we understood that otherwise, the start of flight tests would be delayed by approximately a year.

The railcars pulled the erector with the rocket. This spectacle is also unique, when you see such a behemoth floating across the steppe, unhurriedly, majestically, indeed floating. The railcars, compared to the rocket laid on the erector, are just tiny bugs, difficult to spot from a distance. And yet, these are ordinary coupled mainline railway diesel locomotives.

The entire journey to the UKSS took approximately four hours. The acceptance form for the product by the testers from NIIkhimmash had already been signed, and the operational briefings at the UKSS were scheduled, with the first one already set for that evening, while the product slowly approached the zero mark. The zero mark is the place on the stand where the product is installed and where it undergoes testing or from where it launches.

It has already been said how many systems and structures are involved in the tests.

The ground crew prepared thoroughly for the reception of the product, running through all processes “dry,” without the product. Everything was checked. They waited. The erector took its working position, connected to the power grid, and emitted a characteristic

hum. This signified the beginning of the erector boom's lift with the rocket. The product's lift took 45 minutes. It hung vertically above the opening and slowly settled onto its supports. The bayonets of the launch marks gripped it and pulled it firmly to the support platforms.

It was time to connect the pneumatics, hydraulics, and electrics. All of this was done automatically. The first thing tested after this was the newly formed connections. Were the hydraulic joints leaking? Were the pneumatic joints venting? Had all the electrical circuit contacts found each other?

At first, we were particularly bothered by the automatic docking electrical connectors of the Leningrad design, "Butany." In automatic mode, more than thirty connectors had to be connected simultaneously. And each of them had about twenty-two contacts. Of course, there were some issues. One connector had to be replaced. We proceeded to autonomous checks of individual systems; everything was normal, no deviations from the norms. The complex tests of the rocket were approaching. The minister flew in from Moscow. In those days, it was fashionable to give production gifts for holidays. So we also tried to conduct the first hot firing on February 23, Soviet Army Day.

Early in the morning on February 22, preparatory operations began. It was assumed that the tests would take place during the day. Therefore, work began at 6 AM. Nitrogen preparation was carried out, i.e., the air atmosphere of the hydrogen tank was replaced with nitrogen, then the nitrogen was displaced, and gaseous hydrogen was supplied to the tank, and finally, fueling began.

We were all sealed in the control bunker, approximately 7 km from the rocket. Visual observations were only by television, which, by the way, said little about the state of the product. We received the main bulk of information from the measurement system.

The control room was on the second floor of the bunker, while the first floor was mainly occupied by supporting systems. The command center was located, as it were, on the third floor, and opposite it was the technological systems control room (ground control). But all information came to the "first" in the command center. He was the one who knew what was happening at the complex at any given moment. Reports from all autonomous consoles and the ground control room came here.

"The first" was A.A. Makarov. Next to him were B.I. Gubanov and V.M. Karashtin, Deputy General, head of tests. Behind them were the "big" bosses: the minister, the commander of the space forces General A.A. Maksimov, their deputies, and the heads of the

leading enterprises.

V.S. Rachuk, the chief designer of the hydrogen engine, and I also sat in the second row, intently peering at the television displays where the engine parameters were illuminated. Fueling was nearing its end. Tension grew with each passing minute. The launch cyclogram began. We didn't think to install microphones at "zero" at that time, so on the TV screen, we only saw a picture without sound. Everyone intuitively listened and waited for the roar of the engines.

But then, finally, the long-awaited white cloud appeared under the rocket. Engine ignition! Something bright flashed and... The large screen displayed APP—emergency launch abort. 52 seconds passed from the moment of ignition to this command.

There was a deathly silence. What happened?! And what to do next? There was very little time to think. Could the operation be repeated? The main rule of testers states: "Do not move forward until you understand what happened to the product."

The initial analysis showed that 2.58 seconds after the "launch" command, the temperature in the gas generator of one of the four engines increased. This meant that something had gone wrong with the fuel supply.

As it turned out a little later, the booster pump for the fuel of that engine had stopped. The defect was fully confirmed when the pump was disassembled. It turned out that during the welding of the exhaust manifold to the pump casing, the rotor's thrust bearing was "tacked" along with it.

According to the initial analysis, there was only one conclusion: the fuel had to be drained. The Chief reported to the minister.

—Make a decision,—the minister replied.

I looked at Makarov and realized that something else had happened. He was whispering with V.G. Khaspekov, B.I. Gubanov joined in, and S.A. Petrenko was called over. He approached. What I heard made me feel unwell. We had lost control pressure!

All the valves on the rocket were opened mainly by high pressure from the pneumatic system. And this pressure was gone. The rocket stood uncontrolled, and the 600 tons of liquid oxygen and 100 tons of liquid hydrogen that had been loaded turned into a huge bomb.

A decision had to be made urgently. The first thing that came to mind was to switch the main circuit to the backup one on the ground. No one else could offer another solution.

To do this, one had to go to the fueled product—to this bomb. The minister got involved. Knowledgeable volunteers were needed. The first in this group was V.N. Kuznetsov, an employee of

NIikhimmash, responsible for work safety. With him were Vagif Isaev and four others. Somehow, we didn't even notice when the military, including the commander of the operating unit, disappeared from the immediate vicinity.

The car with the brave men drove to the zero mark. We watched them on the TV screen. Communication was available. They entered the structure and manually shut off the valve.

A sigh of relief swept through the hall. Now, they needed to return quickly.

Time flew by at a frantic pace. The components in the tanks were "swelling." The pressure was rising to the maximum design limit.

While the brave men were driving to the rocket, our engine specialists V.G. Khaspekov, G.Ya. Alexandrov, and V.B. Lyfar frantically searched for other ways out of the situation. Valera Lyfar had the entire pneumatic-hydraulic diagram of the block in his head. He could, as they say, with his eyes closed, in the middle of the night, answer any question about the diagram. He knew the characteristics of every valve, pneumatic panel, pipeline, filter, reducer, etc. This greatly helped the three of them find another bypass route. The pressure had exceeded the permissible limits. Only the safety margin remained. The operational technical leadership was right at the "first's" table.

The Chief received V.G. Khaspekov's report. And then the voice of "the first" sounded:

—Everyone take your places. We continue working.

These words brought relief. Clear commands from the new technological plan, approved by the Chief, followed one after another.

The pressure began to drop, and the components started draining. This process lasted several hours. Then came evaporation.

The minister asked for a list of those who had gone under the fueled machine. He promised a bonus equal to their salary. (He kept his promise.)

The loss of control pressure, as it turned out later, occurred due to the destruction of pipeline C7331-90. I remembered that ninetieth pipeline for the rest of my life.

Now it remained to find out the reasons why this happened. Samples of the broken joint were sent for investigation to TsNIIMV (now NPO Kompozit). S.P. Polovnikov headed this organization, and his deputy Yu.G. Bushuev was the authorized representative at the testing ground.

The next day, the minister called a meeting and asked for a report on the plan for further actions. How much he didn't want to

remove the rocket and return it to the MIC!

The Chief, having analyzed the situation, said that everything could be corrected without removing the product from the launch pad. The engine specialists confirmed that they could replace the booster pump parts at “zero” and that it would even be more convenient. They only asked for the necessary stirrups and a tent for protection from the wind. At the time, this seemed like a very bold statement to me.



Victor Georgievich Khaspekov

The necessary decisions and instructions were made and given. N.S. Shurakov promised to provide the Voronezh residents with everything they needed within 24 hours. Workers from the Voronezh Mechanical Plant, under the leadership of A.G. Plis, began to eliminate the malfunctions in the booster.

The situation with the ill-fated ninetieth pipeline was more complicated. S.A. Petrenko reported the incident to Kuibyshev and asked to simulate such a breakdown on an analogous pipeline. After all, the commission's conclusions stated that the pipeline's destruction along the “KO” line occurred in the heat-affected zone of the weld seam due to poor welding, excessive loading during installation, and damage during operation.

The Samara specialists conducted about a hundred tests of the analogue: they welded by hand, with tension, broke it, pressed it. They still couldn't simulate the defect.

There was only one conclusion—the defect was inherent only to the pipeline that was on the rocket, i.e., it was a singular occurrence. And here, the main word belonged to the materials scientists. According to their report, copper, whose presence in the

metal made that spot brittle and caused it to lose strength, had gotten into the pipeline material, which was specially developed for “Energia.” In terms of its characteristics, the new material was approximately twice as good as existing ones, but it was very sensitive to copper content.

A special commission was sent to Pervouralsk, where the pipelines came from. Traces of copper were found on the rolls. All modifications were carried out on the product. A decision had to be made about further work. Again, a commission. Again, the minister questioned the state of the systems, again A.A. Maksimov ascertained the opinion of his military representatives. Everyone gave the go-ahead to continue. Yu.G. Bushuev especially bore the brunt. He prepared small posters and answered all attacks and tricky questions calmly and confidently, instilling in everyone the much-needed optimism. The decision was made. Forward!

THIRD DIGRESSION

There are leaders who, wherever they are, try to show that they are high-ranking individuals. They tell this to those who don't see it or pretend not to understand. People look at such unfortunate bosses and wonder how they can lead a team?

But there are also other leaders. They always carry themselves modestly, join conversations without interrupting their interlocutors, know how to listen and hear what is being said. They react quickly to all sorts of barbs. Communication with them brings you peace and confidence. You immediately see that the person in front of you is not simple, but a leader.

Among such leaders was Yu.G. Bushuev, Deputy Director for Science at NPO "Kompozit". We met him at the test site. To ensure work on "Energia-Buran," the Minister sent the heads of all industry institutes to Baikonur.



Yuri Georgievich Bushuev

When everyone is on site, issues are resolved promptly. There's no need to send high-frequency telegrams to Moscow or other cities to request necessary data. Everyone was here. Answers to questions were received within hours, and sometimes immediately.

I clearly remember the scene when, in the conference hall before the second operation with rocket 5S, a meeting of the test commission was underway, when Yuri Georgievich stood before the presidium as if rooted to the spot and reported, under a displayed poster, the reason for the failure of that ill-fated pipeline.

"The cause of the destruction is explained by the unacceptable content of copper in the pipeline material. The nature of the change in characteristics is presented in the diagrams," he explained.

And then he elaborated on the technical essence of what was

happening. He answered all questions calmly, confidently.

“Do you guarantee subsequent operation?” the minister asked.

“Of course.”

This report was decisive in making the decision. Later, when we got to know each other better, I was struck by his ability to handle himself in all critical situations: he had endured many personal troubles, including health issues, but always remained attentive to his comrades. He experienced their misfortunes with them, forgetting his own.

For him, even the concept of mercantilism did not exist. For him, there was only the person who was in front of him. Regardless of whether they were a boss or already demoted. It didn't matter. If he believed in someone, he maintained friendship with them forever, and if necessary, he organized help.

Such qualities gave him a special position in his organization, and everyone who interacted with him is left with a feeling of good and significant satisfaction. One wishes to have more friends with such a character.

THE FINAL EXAM

The strict procedure for the second hot-fire test had already been determined. Departure of crews from pad 10 at 4 AM. Everyone had to be at their workstations by 6:00 AM. We didn't want to work through the night again. The nitrogen purge of the hydrogen tank was done in advance.

The work proceeded calmly but very slowly. Constant minor delays pushed the tests into the night.

And so it happened that all fueling operations and final checks ended late in the evening. We worked through the night again.

"Reports, please," A.A. Makarov commanded.

All "numbers" reported the systems' readiness for the hot-fire ignition of the central block engines of the rocket.

Again, a light white smoke erupted from under the rocket. Through the installed speakers, we heard a growing noise, very faint at first, and now it had turned into a steady hum.

All engines reached their operating mode. Now they needed to complete the full program, which included thrust forcing and throttling, engine gimbaling, as if simulating rocket control, and all of this had to be completed in 390 seconds.

Silence reigned in the control room. Only the crackling of the consoles transmitting information to the displays could be heard.

100 seconds passed. A certain relaxation set in. Maybe we'll make it through. So much energy and effort had been invested in preparing these tests. It couldn't all be in vain.

The engines operated for 200 seconds, which meant that the hydraulic power units ensured the operation of the steering machines, pulling the engines back and forth.

These machines developed a force of about 30 tons. But where would they get that in flight?

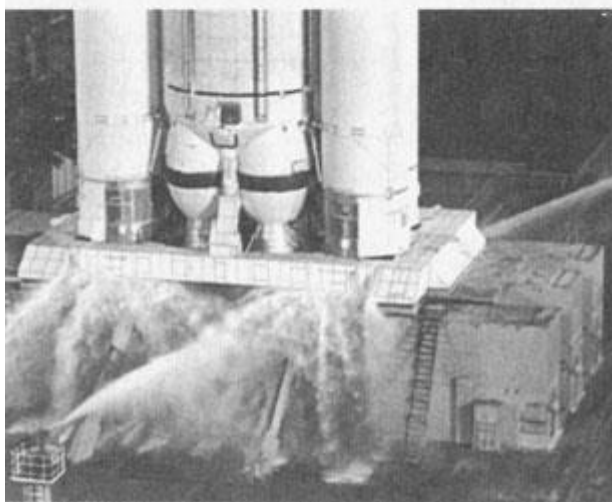
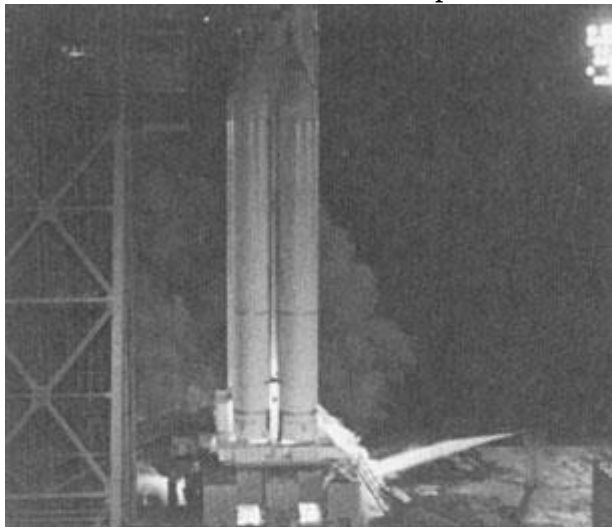
That's why a special turbine was installed. It was driven by high-pressure hydrogen tapped from the engine. The turbine, through a gearbox, rotated the Balashikha pump, which created the necessary working pressure in the hydraulic circuit. All that remained was to correctly, quickly, and precisely redistribute it in the working cylinders.

All the problems with the development of both the drive and these distribution mechanisms immediately surfaced.

The drives were developed by the oldest aviation engine-building company, led by A.M. Lyulka. This company was our long-standing co-executor. It was there that the hydrogen engine for the

40-ton-force (40 tf) thrust warhead of the N1 rocket was created. We had good comradely relations with this company. And we were very glad when they took on this drive.

The requirements for it were set very strictly in advance. Leakage from the gearbox was especially not allowed. These requirements could not be met in a vertical position.



Hot-fire test of the second stage engine unit of the launch vehicle on the UKSS

And I'll remind you that the central block contained 600 tons of liquid oxygen. The compatibility of oil and oxygen is well known to everyone—it's an explosion. The reasoning was: if there's oil, oxygen will be found. We didn't withdraw our requirements. That's when the chief designer of the drive, Juvenaly Marchukov, without telling us, went to the General for an audience.

“Valentin Petrovich! We are engine builders. Only you will understand this problem of static sealing. We have tried all methods. We won’t be able to achieve more. We need to find a solution together,” Juvenaly explained his difficulties.

Valentin Petrovich, as always, listened very carefully to the essence of the technical problem and called us in.

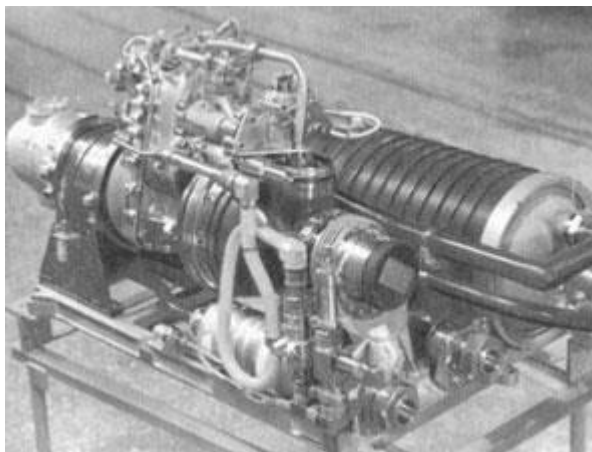
“What are your thoughts on the problem described and what do you propose?”

V.V. Kudryavtsev and I began to list what else could be done, but it was already too late. From V.P.’s distracted gaze, we understood that he had already made a decision and only listened to us for the sake of formality.

“We need to meet Juvenaly Pavlovich halfway,” V.P. said. “Think about how. Maybe change the location and rotate the drive? Think about what’s best.”

Cursing to ourselves, we left the office. We certainly found a solution, but we had to change the work technology with the rocket.

And the story with the distributors was no simpler. They were manufactured in Saratov and called CAPFs—digital-to-analog phase converters. They were handled by instrument production, where high cleanliness requirements are in place. But during tests, the steering drives at Leningrad’s “Arsenal” “caught” remarks. It was determined that the cause was in the CAPFs: dirt was found inside this small element. What a commotion that caused! The Minister gave everyone a dressing down in turn for poor production, for not supervising it, for the lack of author’s support, and... Everyone got it. All manufactured batches were returned to the factory with a suggestion to wash them.



Hydraulic power unit for steering drives, providing working pressure in the circuit of the steering drives for turning the second

stage engines

“We don’t need to get into trouble because of some speck of dust,” he instructed.

Now 250 seconds had passed, and the steady hum of the engines in the speakers gradually calmed everyone in the command hall.

No power failures on board. Four turbogenerator power sources worked flawlessly. After all, they are the ones that provide power to the central block in flight. Previously, chemical power sources, called batteries, were installed on rockets.

But the power requirements for such a large rocket demanded so many batteries that it was simpler to install a generator. Which was done.

Like the hydraulic power drive, it operated from the engine. Hydrogen rotated the turbine and drove the generator rotor.

The developers of these unique TGSEs were our namesakes from Voronezh—NPO “Energia,” although this organization belonged to another ministry.

The boldness and simplicity of the decisions made this unit reliable. For which great thanks go to the chief designer B.P. Popov, his director V.D. Sergeev, and especially the test engineer M.V. Komarov, who alone was responsible for the TGSEs at the test site.

300 seconds. How quickly thoughts race through one’s head: how is this system or this unit behaving? But the constant numbers on the display indicate that everything is going according to plan.

390 seconds. Dead silence, end of work. And then an explosion of applause. Everyone stood up. On their faces—satisfaction with what had happened.

What a boost to work good results give!

“We’ll fly on the next machine,” the Chief whispered to me.

But I didn’t believe it. After all, it wasn’t 393 seconds of hot-fire tests that needed to be passed, but 3700 seconds, as required by the comprehensive experimental development program. Without changing it, flying was out of the question.

At a special meeting of the MVKS on May 5, 1986, a clarification was adopted. Before the start of flight tests, three hot-fire tests with a total operating time of 423 seconds were to be conducted. It was assumed that the third hot-fire test would be conducted on rocket 6S.

Confidence emerged that the central block was prepared for flight tests. This confidence was internal, unfounded. The flight was still oh so far away.

All our work was controlled by customer representatives, or simply put, military representatives. Earlier, I wrote about the

purpose of the “Energia-Buran” system. Let me remind you that the tactical and technical assignment for the development of this system was issued to us by the Main Directorate of Space Forces under the Ministry of Defense. A.A. Maksimov headed this directorate.

A special concern of the military representatives was the control of the quality and reliability of the system. According to the scenario, the “Energia-Buran” system was to be adopted by the Soviet Army. Any deviation from the previously developed documentation of the Chief Designer had to be formalized by a separate technical decision, agreed upon with the customer. That’s where it all began. People are people. Some quickly grasped the essence of the technical problem, others put up so many obstacles, demanded so many technical references, that sometimes it drove even the most patient developers crazy.

To some extent, we were lucky that the rocket department in GUKOS was headed by N.I. Rumyantsev and V.E. Nesterov, who were well-versed and technically competent. The latter probably spent no less time at the test site than we did. He was one of us, not by official position, for he was a lieutenant colonel at the time, but by technical education. V.E. Nesterov, like most rocket scientists, graduated from the Moscow Aviation Institute, joined the army, graduated from a military academy, served as a military representative at one of the industry’s enterprises, and then moved to the central apparatus.

But something “MAI-like” remained in him. Good technical erudition, good humor, a sufficient supply of optimism. Volodya somehow unofficially became the leader of the huge family of military representatives at the test site. He had a good memory, kept a technical diary, and was always a very good assistant to the Chief or his deputies.



Vladimir Evgenievich Nesterov

The military representatives—product specialists and ground crew—promptly informed him of events that occurred, which he organized and, depending on their importance, passed on to the technical leadership of the appropriate rank. Of course, the military system required reports “upstairs” as well, and this was carried out very carefully.

Having thoroughly studied the design of the engines, the control system, pneumatic-hydraulic diagrams, and other systems, Volodya became an indispensable consultant, including for our developers. This greatly helped us and the industrialists in coordinating the necessary technical solutions aimed at improving the quality of the systems.

Now, when I wrote that the MVKS adopted a shortened hot-fire test program, you can imagine how many “pounds of salt” had to be eaten with such customers. They laid out before us the hot-fire development of both the American “Saturn-5” rocket and the American “Space Shuttle,” for which the hot-fire tests of similar blocks lasted 3600-3800 seconds before launch. And here, only 423...

Try to cope with such luminaries! Only the instructions of higher command could not be ignored—this was essentially an order. It was these instructions that ultimately led to the MVKS, at the insistence of the Chief, adopting this decision.

But we seem to have forgotten about the side boosters. And there were four of them in “Energia.” And although they were significantly inferior to the central block in complexity and testing, there were many problems in their development and manufacture.

FIRST STAGE

So much attention was given to the creation of the second stage that those involved in the first stage might have been undeservedly offended.

It is worth reminding readers that V.P. Glushko's arrival in our organization was characterized by his proposal to create a series of unified carriers. The smallest and simultaneously basic was a medium-class carrier, capable of launching a mass of 14 tons into Earth's orbit. The first stage of this carrier was based on the most powerful liquid-propellant rocket engine developed by the Energomash Design Bureau, with a thrust of 740 tf.

This stage, as a unified element, was used for the first stage of the "Energia" rocket, in the amount of four blocks.

The development of the super-heavy launch vehicle "Vulkan" was also envisioned, capable of launching a mass of up to 200 tons into Earth's orbit, with eight blocks installed in the first stage.

We closely followed our colleagues from the Yuzhnoye Design Bureau. After all, our fate depended on their success.

Things were not going well for them. The engine development was particularly intense. Its first test as part of a block led to an accident with a large fire at the NIikhimmash test stand. The intensity of the fire is indicated by the fact that it took two years to restore the stand.

Many did not believe in the creation of a super-powerful engine. There were "smart alecks" who proposed to "quarter" this engine and get an engine with a thrust of 185 tf — the MD-185. I.N. Sadovsky asked us to work out such an option.

The development of this option also began at the Yuzhnoye Design Bureau: after all, the fate of the medium-class launch vehicle, named "Zenit," also hung on the engine.

Minister S.A. Afanasyev created a special group at the Energomash Design Bureau for detailed development of the MD-185 engine. He could be understood. After all, the entire rocket industry of the country was already in full swing. Factories were completing production preparations, i.e., equipping with the necessary technological equipment, construction at Baikonur was in full swing, the construction of the largest test stands was nearing completion, but there was no engine. One would inevitably get nervous.

Attacks on the engine came from all sides. Industry institutes joined in. Criticism, criticism, criticism...

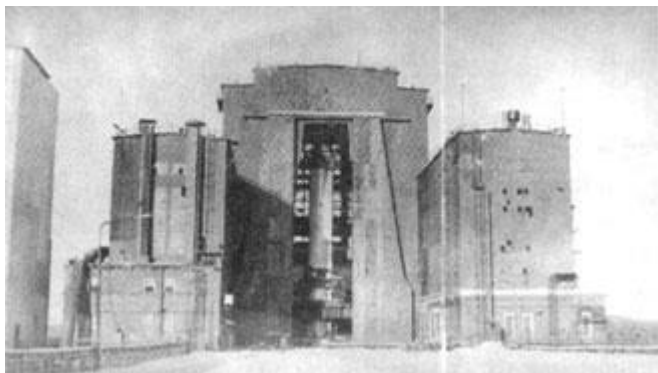
contacts with other Generals. At the Yuzhnoye Design Bureau, they also began developing a rocket with a quadrupled engine.

They began to assemble a new engine, started looking at engines used on the N-1 rocket. Everyone scurried in search of an alternative solution. All this happened during V.F. Utkin's vacation.

When Vladimir Fedorovich returned from vacation, he was briefed on the search for new rocket options. He listened carefully to his colleagues and said:

— Aren't you ashamed? Our comrade is in trouble, and instead of helping him, you have already abandoned him. You probably forgot that all our rockets are equipped with his engines. Has he ever let us down?! I don't want to hear about any other options. We will wait. I am sure that Glushko will cope with this task. That's it!

This confidence was involuntarily passed on to the engine designers. I think V.P. Glushko was very happy with such support. History itself has shown how far-sighted our Generals were. Today, the whole world looks at "Zenit" as the best rocket.

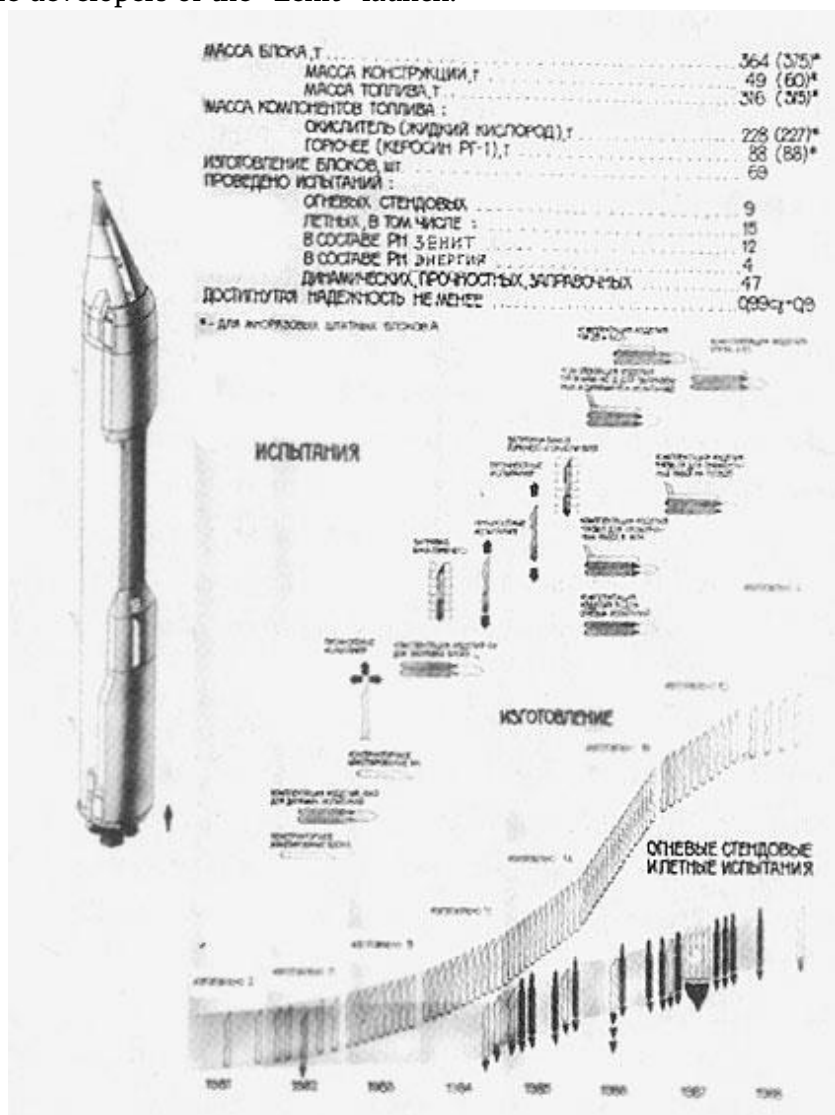


Test stand for fire tests of the first stage block propulsion system

Our designers also had many questions to solve. The peculiarities they were used to were not entirely suitable for the southerners. The southerners, when creating the "Zenit" launch vehicle, focused on their large-scale production plant. They knew it well, so they based their developments on the equipment of this plant.

The adjustment was difficult, but everyone was united by one common goal — the "Zenit" and "Energia" rockets. It should be noted that wayward leaders sometimes added other kinds of difficulties to the relationship, but now this seems insignificant and petty. Although the "clashes" were major, such as the choice of material for the tank bodies. Many will remember this story for a long time. The "Zenit" rocket was designed under the order of the Ministry of Defense, and gradually the work on the rocket grew into an entire complex! The original launch for "Zenit" was developed at

the Transport Machine-Building Design Bureau. They followed the path of a fully automatic launch without human involvement after the erector left the MIC. A similar launch was once developed at OKB-1 for the 8K75 combat missile, which stands in front of the Museum of the Soviet Army. Unfortunately, the rocket was not accepted for serial production, I don't know for what reasons. They say it was N.S. Khrushchev's intrigues. But a similar fully automatic launch was developed back in the 1960s. I think it greatly helped the developers of the "Zenit" launch.



Development plan for the first stage block of the "Energia" launch vehicle

The rocket's fire tests were completed. The work at the stand ended positively. The entire process of rocket development was

completed.

Here it is, the beautiful pencil — that's what they called the rocket, which, with its outlines indeed resembling a pencil, stands on the launch pad.

The first launch was scheduled for April 12, 1985. But the weather seemed to go wild; a strong wind with dust and snow raged over the test site. As if someone "from above" didn't want it. It was postponed for a day. They couldn't celebrate Cosmonautics Day.

April 13, 1985. Again 12 o'clock. We are on the observation deck. Gloomy sky. Agonizing minutes. I especially remember how nervous one of the "ground crew" from the Yuzhnoye Design Bureau was.

— If only it leaves the launch pad, — he repeated every minute, nervously pacing the observation deck.

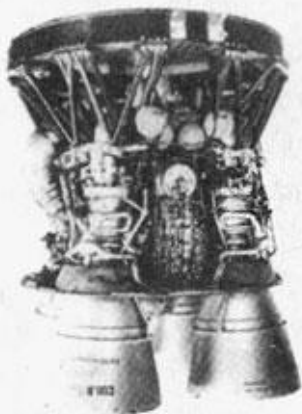
— One minute to launch, — a voice sounds from the loudspeaker.

Everyone intently peered at the "pencil" on the launch pad. The image of the accident at the stand during the first fire test clearly resurfaced.

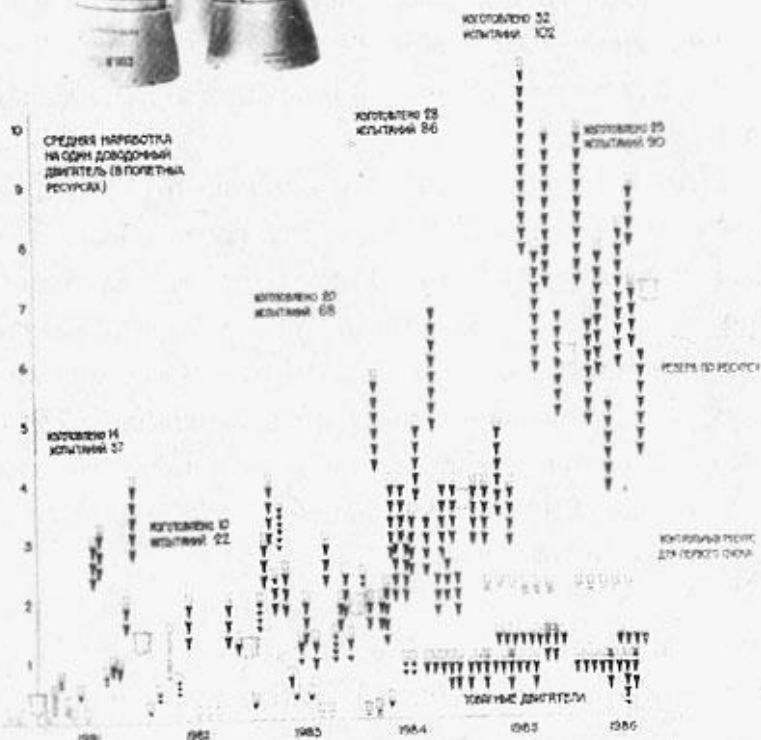
A cloud burst from the side of the rocket. That's the engine start. Liftoff! The rocket rapidly ascends, pierces the cloud layer, and sets on course. Everything happens in a matter of seconds. But how they stretch in memory over time.

— It's gone, it's gone, it's gone! — first in a whisper, then louder, the ground crew rejoiced.

The flight progress report was broadcast over the loudspeaker. There's the first stage, there's the second, the steering engines are working, bringing the spacecraft to the desired orbit.



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Operating time on the first stage development engine during testing

— Hooray! — everyone clapped their hands and rushed to the cars. Faster to the launch pad.

The Chief and I were among the first to arrive. The metal was still warm, even the paint hadn't burned off. Jubilant Dnepropetrovsk residents. Everyone hugged and congratulated each other. A rally. The chairman of the State Commission, G.S. Titov — cosmonaut #2 — spoke. He congratulated everyone: V.F. Utkin, V.P. Radovsky, and V.L. Lapygin (the developer of the control system), everyone. Only V.P. Glushko's congratulations were not heard. And he stood, calmly observing everyone. His whole

demeanor suggested that this was how it was supposed to be. He took the floor and congratulated everyone on the successful start of flight testing.

This, it seemed to me, immediately sobered everyone for a few minutes. The joy of victory took its toll. Everyone began to disperse to their hotel rooms, and the leadership went to a special dining room. The joy was celebrated in the best traditions of rocket scientists. It turned out that many had saved a bottle for this occasion, and those who didn't have one made do with a proven drink — rocket fuel — alcohol.

In the morning, at the meeting of the State Commission, it turned out that the steering engines failed in the last seconds. This somewhat saddened, but did not upset, the Dnepropetrovsk residents. For the rocket scientists, the success was real.

The first launch showed that the side blocks of the “Energia” rocket were ready for flight. The next stage was approaching — the flight tests of the “Energia” rocket.

LAUNCH

1986 approached unnoticed. About two days before the New Year, the duty officer of the enterprise called in the evening:

— Vyacheslav Mikhailovich?

— Yes.

— This is the duty officer of the enterprise.

— Listening.

— You need to be at Vnukovo-3 at 9 AM on January 2nd.

Flight to the test site. The minister is flying.

What a surprise! I hadn't even been home for three days, and I was already back at the test site. Asking the duty officer questions was useless.

The only comforting thought was that trips with the minister were short. We celebrated New Year's. And on the morning of January 2nd, at 9 AM, I arrived at Vnukovo-3. I was surprised by the crowd. My Chief, Chief Designers of systems, military personnel. I went to register for the flight. Three TU-134s were flying to "Krainiy," as the airfield at the cosmodrome was called.

O.D. Baklanov arrived. Boarding was announced. All planes took off with a ten-minute interval.

The three-hour flight passed unnoticed. It was announced that upon arrival, everyone should gather at the Officers' House. We landed in Leninsk and immediately went there, to the fourth floor, to the small hall.

— I must inform you that we will not leave here until we launch the rocket! You can only leave the test site with my personal permission. I don't think anyone has any questions. I will name the representatives of the ministry and industry institutes who will be here with you.

The Minister appointed representatives no lower than deputy heads of main departments. These included engine specialists, technologists, managers, suppliers, etc.

A.A. Maksimov spoke. He said that the Main Directorate of Space Forces would also organize its permanent representation at the test site.

An office for the Main Directorate of Space Forces was urgently set up at site 112, next to the minister's office.

To launch, then to launch, but what? Many asked themselves this question. And here I want to talk a little more about this first flight vehicle.

The development plan provided for two test stand rockets. This

can be converted into a flight vehicle. But this must be between us.

— That's difficult. There's armor protection and a number of other design solutions that are very hard to bypass.

— That's your problem.

— Okay. I need to think about it. I need the initial data.

— We'll provide that.

It all started with that conversation. Our Volga branch frantically reworked the documentation package for the new product.

B.I. Gubanov approached V.P. Glushko with a proposal to convert the 6S test stand rocket into the 6SL flight version.

— Such a thing is hard to come up with even when drunk, — Valentin Petrovich replied.

The idea of creating the 6SL rocket, as it came to be called, was supported by the minister. He was well aware that the manufacturing cycles for the central block were very long. Therefore, the decision on the 6SL brought the start of flight tests forward by almost a whole year.

Oleg Dmitrievich called the Chief and began to "promote" this idea.

— We need to convince Glushko of this.

— I'll take care of that.

A week later, V.P. invited the Chief and cautiously began to suggest that flight tests needed to be accelerated, and perhaps even the 6SL should be launched.

— But you yourself said that it was...

— Yes. I said that. But today the situation has changed, and if all precautions are taken, I think we can work on this.

Thus, the General's approval for this idea was obtained. Before the launch, dynamic tests of the assembled rocket, fire technology tests of the package, as required by the comprehensive development program, and, of course, the launch pad had to be ready.

Without solving these three main problems (not to mention a thousand minor ones), there could be no talk of a launch.

When designing the universal test stand-launch complex, our ground crew, and primarily V.M. Karashtin, had no idea that this complex would become a launch pad so quickly.

The launch of a flight article from the Universal Test and Launch Complex (UTLC) was not foreseen. Therefore, it was not equipped with service platforms for the package (as we called the assembled rocket). This mainly applied to the first stage blocks.

Air for thermostatic control and electrical circuits needed to be connected to the nose sections.

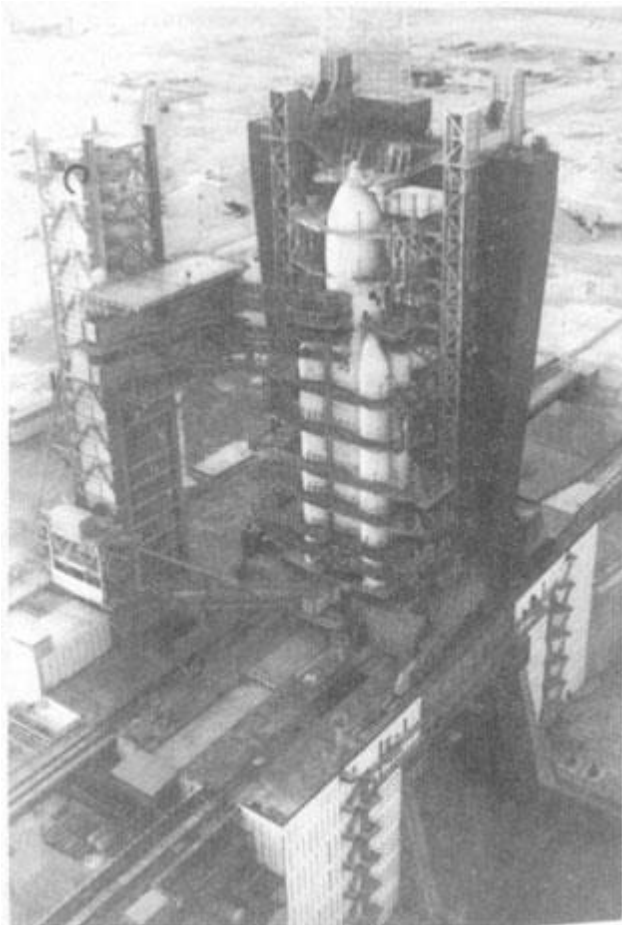
We went to Academician V.P. Barmin. We told him about this

idea. He didn't want to hear about such modifications. He believed that the first launch of "Energia" should take place from the standard launch pad, the readiness of which was far from complete at that time. Any diversion of funds and attention from the construction of the launch pad could lead to delays in its commissioning. Here it must be said that V.P. Barmin was personally responsible to the minister for commissioning the launch pad. Hence, probably, his reluctance to deal with the modification of the UTLC.

We had to turn to our experimental complex, to A.A. Rzhanov and the director of the experimental machine-building plant, A.A. Borisenko. They began the development and manufacture of additional mechanisms for servicing block A on the UTLC.

These mechanisms had to be placed on service platform 3 and jettisoned from the product a few minutes before launch. So these mechanisms were not so simple. We called them "horns and hooves," perhaps because after jettisoning they dangled somewhat strangely on the platform. It was not an easy task to bring them to good reliability.

Petrovich chased them for a long time. But they managed to prove their point. And then V.P. Glushko could no longer back down. He began to prove the necessity of this stand at the very "top." The test site was in the hands of the military, and they didn't need experiments. So they refused the order for this stand. NPO "Energia" had to take on this order. Years passed with disputes about the necessity of the dynamic stand. And, of course, the stand was not ready for the first launch, let alone for the 6SL article.



"Energia" launch vehicle on the UTLC

The meeting with the General lasted a long time. They were looking for a way out. Our load specialists, together with colleagues from TsAGI, found it. They broke down the complex tests into separate, specific ones. They theoretically proved that a series of such specific tests would replace the stand tests. V.P. Glushko agreed to this experiment, but for a single launch. He believed that the stand would still be needed to study the characteristics across the entire range of loads. He did not stop the construction of the stand.

A special full-scale rocket mock-up, named 4MKS, began to be assembled. It allowed for fueling and dynamic testing of the rocket.

So, on August 13, 1986, the mock-up was on the UTLC. In just twelve days, the fueling of the package was completed. This included about 100 tons of hydrogen in the central block, over 1000 tons of liquid oxygen in the central and side blocks, and kerosene in the side blocks. And all in just 12 days. Makarov's guys and our system engineers did a good job. The military of the 6th Directorate also did not disappoint. Their technical systems worked without failures.

After fueling, dynamic tests were carried out directly on the UTLC, determining the frequency characteristics of the package. Then the product returned to the MIC, where the tests continued.

But the most difficult issue turned out to be the conduct of fire technological tests (FTT). Everyone understood this issue. Such tests were provided for in the development program.

Their essence was as follows: A fully assembled rocket was installed on the UTLC. It was secured to the launch table. Fueled. Then all engines of both the central and side blocks were started, which operated for about 30 seconds and then shut down. In this way, all rocket systems were comprehensively checked.

These tests were to be the final ones before launch. Their main purpose was to eliminate technological errors during rocket assembly. This was despite all autonomous and complex checks. After the fire tests, residual fuel was drained from the rocket, and it was inspected for defects. A payload was installed on it, and it was returned to the launch pad, but this time for flight.

What a paper war we had to endure with the institutes, the customer, and the "higher-ups"!

The idea of abandoning FTT belonged to the Chief. He didn't immediately find allies even within our design bureau. But gradually, the idea took hold among the developers.

Hundreds of reports and explanations had to be written by our engine specialists. They even came up with a replacement for these tests. V.G. Khaspekov proposed conducting CTT — cold technological tests. Their goal was the same — to minimize the possibility of technological defects.

The military was adamant.

— How can you not understand that this is a 450-ton bomb standing and rumbling on the launch pad? Let's release it into flight. If anything happens, we will lose the launch pad, — B.I. Gubanov argued to the military and the Central Research Institute of Machine Building of the ministry.

The brilliant director of this institute, Yu.A. Mozzhorin, who

had experienced all the pitfalls of the H1 rocket, cautiously warned the Chief but was inclined to support him.

The minister created commission after commission. He involved the Academy of Sciences. He organized a seemingly independent neutral commission under the leadership of Academician K.V. Frolov. But as soon as a military man joined the commission, a dissenting opinion was always written. What discipline!

Before the launch, they squeezed a not very convincing conclusion from K.V. Frolov's commission, stating that, it seemed, one could proceed with the launch without FTT, but also, it seemed, one could not. Everyone could interpret it in their own way.

Current issues were resolved promptly. And there were hundreds of these issues. Dents on bellows, failures in level measurement system sensors, dents on engine combustion chamber nozzles, increased leakage in the hydraulic power unit, and so on.

But the development of the flight control system's mathematical software caused particular concern.

That's where our Kharkiv colleagues got it. Ya.E. Aizenberg was directly responsible for this topic at NPO "Khartron." The minister knew him personally well, perhaps that's why he received fewer "watermelons" for missing deadlines. But the Kharkiv residents worked selflessly.

I remind you that there were five of their computers on board. The latest firmware for the read-only memory (ROM) arrived by plane just before the launch.

The assembly of the rocket, or rather the central block, entered a mode according to which previous products were assembled. Twenty joints were welded per shift, and no matter how much leaders of all stripes pushed, the assembly rates did not increase.

Monotonous workdays brought despondency. Only V.P. Glushko, with unflagging energy, worked on the "Space Encyclopedia." But soon even he couldn't take it anymore.

— Tomorrow, Oleg Nikolaevich, I'm flying to Moscow, — he said one day at lunch to Deputy Minister O.N. Shishkin.

— I'm not against it. But you know the minister's instruction. Until the launch! — O.N. Shishkin replied.

— Then maybe you'll send me my wife?!

Everyone at the table froze. Oleg Nikolaevich couldn't find anything to say to the 77-year-old General Designer. In the morning, V.P. flew to Moscow.

The minister was hedging his bets on all counts. He also involved the President of the Academy of Sciences, A.P. Alexandrov, in our affairs. He personally took him around all the sites of the test

range, demonstrating the grandeur of all the facilities, the rocket, and the orbital vehicle.

1986 flashed by. We were allowed to celebrate it at home. But in the new year, the tension did not subside.

On February 11, 1987, the first flight article with the "Polyus" spacecraft on an external suspension moved to its final stage of checks at the UTLC. Its launch is planned from here.

When the decision was made to make the 6S rocket flight-ready, we faced the fact that there was nothing to launch it with. O.D. Baklanov went to the general designer of the Salyut Design Bureau, D.A. Polukhin, and asked him to make a cargo mock-up of one of the spacecraft being developed in that organization. The deadline was one year.

The Design Bureau and the plant in Fili had to put in a lot of effort. It's no joke to say that the spacecraft had to weigh almost 100 tons and also have a propulsion system. Its purpose was to boost the spacecraft itself to its operational orbit. The last stage of the "Energia" rocket, to avoid polluting space, would fall into the antipodal point (relative to the launch) of the globe — into the Pacific Ocean near Australia — after exhausting its fuel.

D.A. Polukhin was quite often present at our operational meetings. He listened carefully to all our technical problems and often repeated in a small circle:

— It won't come to me!

It was offensive to hear such words. But it was even more offensive to hear them on the eve of the launch at our enterprise from the mouth of the head of the theoretical complex. At lunch, he uttered:

— Tomorrow I'm flying to the test site. They're calling me. It's a completely hopeless case.

— Why go then? — I ask.

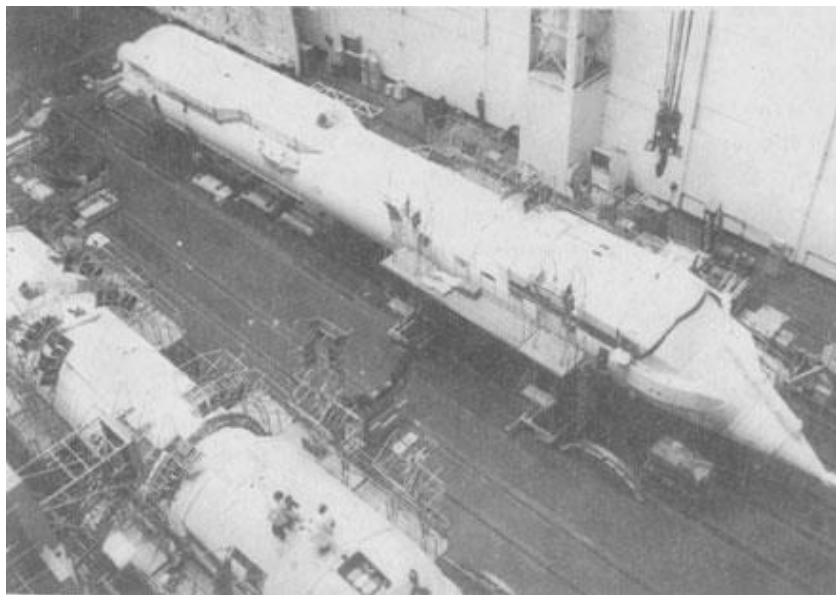
— I said they're calling me. I have to report on safety issues along the trajectories. I don't think it will come to trajectories, but the report needs to be made. So I'm flying tomorrow.

Something stirred inside, but I held back. Such a person will always be right. This year's winter was very snowy. In spring, we couldn't keep the equipment in the under-table room from the water that seeped from all cracks. For electrical systems, this was especially "pleasant." During tests, we constantly "caught" either a "plus" or a "minus" on the casing. We dried, fixed, and moved forward.

Practically everyone, from the engineer to the Chief Designer, was concerned about the product. I will give one of many examples.

In April, when there were just over three weeks left until the

first experimental launch of "Energia," V.V. Mashchenko, the head of the design team from the GKB NPO "Energia," entered the lead engineer's office. His face showed anxiety. He asked to go down with him to the bay of the MIC, where the rocket's side blocks were being assembled. We approached one of the already finished nose cones, intended for the 1L product. We climbed inside using a ladder. Valery unfastened the hermetic cover, and before us were the control system instruments installed on shock absorbers, connected to the onboard cable network. It was striking that the wire harnesses leading to the connectors on the instruments were unusually taut. According to existing norms, when connecting cables to equipment, they should have a certain slack to prevent their destruction during vibration (most often, detachment at the soldering points on the plug). In our case, the shock absorbers allowed the instruments to move up to 20 mm in any direction, but the cables were mounted taut! In case of a launch, an accident would be inevitable — there was indeed cause for concern.



First stage block. Assembly in the MIC

We checked the cable routing on other "noses." The same thing! This is a scandal! And how are the cables mounted on the rocket already prepared for launch? What if this isn't an accidental defect? We got into the RAF and rushed to the rocket standing on the launch pad, awaiting launch. How helpful are passes with "all-terrain" stamps in such situations! A few minutes later, taking the duty officer with us, we were already on the service platform near the hatch we needed. Five more minutes later, we confirmed the worst: the same defect was present on the side blocks of this

product. Actually, there was no catastrophe yet. The cable lengths were certainly correct. Most likely, it would only be necessary to cut the keeper tape, which wraps the branching ends of the harnesses, and re-tie them, but with the necessary slack. But how could this have happened? After all, both the designers in the design bureau and the installers at the factory are skilled people. We decided to also check the routing of the cable harnesses in the inter-tank compartment of the central block — this is a product of another factory and according to the documentation of another design bureau. Here everything is in perfect order! That's good, now we just need to fix the defect and find an explanation for its appearance.

We returned to the MIC and retrieved the documentation for cable installations. In the set of drawings for the central block, it was written: “ensure 70 millimeters of slack” — everything was clear and understandable, but in the documentation of our own design bureau for the side blocks, we read: “slack — according to GOST...”! A typical mistake of a “young and untrained” designer. He showed off his knowledge of standards but failed to consider practical wisdom: write simpler — it will be better! The next step was a call to the most respected representative of our factory's assembly shop, Alexander Levonovich Gevorkyan. He and his guys would have to crawl over the product and correct the error. We immediately agreed with him: everything could be completed in eight to ten hours. Now it was time to report the completed “scientific research” to the Chief — we went to him to sign the prepared and agreed technical instruction.

Thus, a casual glance at the product by one person (plus his highest professional qualification, plus his sense of responsibility for the work) most likely helped prevent billions of dollars in damage.

Closer to the May holidays, many of the leadership somehow unnoticed found themselves in Moscow. Learning about this, the minister asked his deputy O.N. Shishkin, V.P. Glushko, and V.P. Barmin to go to the test site during the holidays. They were to personally oversee the progress of the tests.

I recall a very interesting incident when two respected academicians were settling scores at a meeting of the technical leadership.

On April 28, the cause of a hydraulic shock in the gas duct cooling system was investigated. When six pumps were started, a plug blew out. The bolts failed. They were sent for expert examination to a materials science research institute. The research institute concluded that the bolt material was chosen incorrectly and that they were bound to break. The wrong grade of steel.

At the meeting, which was chaired by O.N. Shishkin, V.N. Klimov, V.P. Barmin's deputy, reported on this. The academicians sat on either side of Oleg Nikolaevich.

After the report, V.P. Glushko said:

— Vladimir Pavlovich, you can't even design a ground system.

V.P. Barmin flared up:

— And you, esteemed Valentin Petrovich, are generally a dilettante in rocket development.

A squabble ensued. Shishkin tried to calm them down as best he could. Finally, silence fell. The academicians sat sullenly. A way out of this delicate situation had to be found. Then O.N. Shishkin addressed everyone:

— Comrades! You young people here. Do you think they are arguing among themselves? These are respected people who laid the foundations of rocket technology. Do you see their age?! No, they are not arguing. It is passion for the work speaking. I wish everyone to be so passionate about their work, and then the job can be done.

The academicians' faces softened. They were very pleased with this turn of events.

Tension grew with each passing day. The launch was scheduled for May 13, 1987. At this moment, General Secretary of the CPSU Central Committee M.S. Gorbachev arrived at the test site. He was shown launches from the left and right flanks of the cosmodrome. Everything went smoothly.

But permission for the "Energia" launch was not given. Mikhail Sergeevich walked through the MIC. An impromptu meeting gathered.

— Well, are we going to launch? — M.S. Gorbachev asks.

— We will, we will, — the workers reply.

— Did you assemble it well? Do you believe in your rocket?

— We believe! Launch!

This launch was very much needed, and a successful one was needed. The meeting in Reykjavik had just taken place. Approval was given for the launch on May 15, 1987. A very interesting date.

May 15, 1943 — first flight of the BI-1 aircraft with a liquid-propellant rocket engine, piloted by test pilot G. Bakhchivandzhi.

May 15, 1945 — first flight of a jet-powered aircraft in England.

May 15, 1957 — first launch of the R-7 intercontinental missile, later named "Sputnik" as a launch vehicle.

May 15, 1958 — orbital insertion of the first scientific laboratory — the third artificial Earth satellite.

May 15, 1960 — launch of the first experimental unmanned

"Vostok" type spacecraft.

And our May 15, 1987. What will it be like?!

Usually, before a launch, the entire combat crew is assembled. This includes military units, management, and civilian operators. General V.E. Gudilin set the task for those assembled. He explained in detail the goals and objectives of the tests. He urged them to follow only the Chief Designer's documentation. He urged them to be very careful when performing operations and to report all deviations as commanded.



Spring 1987. M.S. Gorbachev visits the Baikonur Cosmodrome. Explanations on the "Energia" launch vehicle facilities are given by Chief Designer B.I. Gubanov

O.N. Shishkin also spoke. He stepped forward in front of the formation. He paused and, as if gathering his thoughts, said:

— Well, with God's help!

Everyone became animated. In those days, it sounded unusual. On May 14, everyone took their places again. I remind you that they wanted to show the launch to the General Secretary, but he flew away the day before.

— I would have stayed, — the Chief said to CPSU Central Committee Secretary L.N. Zaikov.

— That's why you're not the General Secretary, — L.N. Zaikov replied.

The leadership flew away. It was time to prepare for the launch. Technical director B.I. Gubanov, deputy test director V.M. Karashtin, combat crew commander General V.E. Gudilin, and test director A.A. Makarov took their places. Behind them were O.D. Baklanov, A.A. Maksimov, heads of institutes, and General Designers of various systems and individual blocks.

We were simply "lucky." No matter how we calculated the preparation time, no matter how we scheduled it minute by minute,

the main operations somehow always stretched into the night.



Leadership of the "Energia" 6SL launch vehicle launch: P.S. Bratsikhin, G.P. Ponomarev, V.M. Karashtin, B.I. Gubanov, V.E. Gudilin, A.A. Makarov, N.I. Kovzalov, V.M. Filin (seated), A.M. Svinarev, A.F. Vysotsky

It was already dark. Fueling of the rocket began. This procedure lasts about four hours. It's good to follow a well-trodden path. After all, the fueling operations were well-practiced by this time.

The tanks are filled to the required level. The component thermostatic system in the hydrogen tank can now be closed.

But what is this? The valve doesn't obey the command. The command to close the valve was repeated multiple times, the controlling high pressure (about 200 atm) flows into the valve, but its seat does not block the passage.

Thoughts race wildly. How can this be?! So many tests: design, first sample, refinement, climatic, vibration, reliability, and it doesn't obey.

A pale A.M. Shcherbakov approaches the Chief. He needs to explain, and not just explain, but also suggest what to do. The explanation that the climatic tests were done in liquid nitrogen, not liquid hydrogen, did not give hope for success.

And thoughts race. And it already seems that the machine needs to be drained, removed from the launch pad, taken to the MIC, the faulty valve cut out, and so on.

V.G. Khaspekov came to the rescue.

— I propose to activate the neighboring valve. Its design is very similar. An additional force — a jolt — could be transmitted from an impact on the tank shell, and the valve might operate.

— Good, — the Chief gives his approval.

Makarov and the specialists quickly develop a small cyclogram

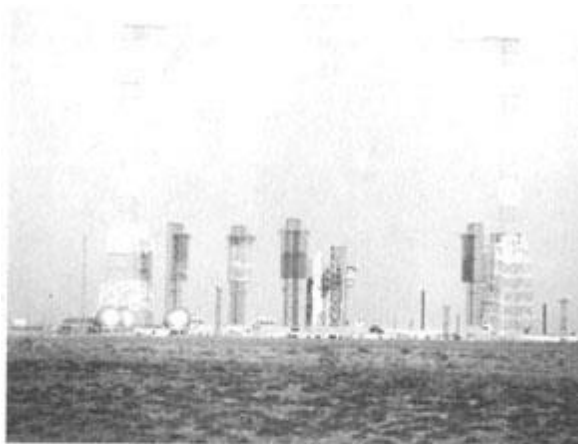
for this operation. Everyone signs off.

The tension in the hall is immense. The silence is so profound that a mosquito's squeak would seem louder than thunder.

But then this neighboring valve activated and the necessary one immediately closed. Phew! Everyone breathed a sigh of relief. It was time to activate the "Launch" command. It is given 600 seconds before liftoff. The control system automatically manages this entire process. We only monitor how the marks pass. Each mark could trigger an abort if the product's parameters at that moment did not match the required ones.

10 seconds to launch. Everyone was literally glued to the TV screens. 6 seconds to launch. Now the water cooling system for the flame trench will turn on. 1000 cubic meters of water should erupt into the flame opening. No water was visible on the screens! A bright flame appeared under the rocket with a simultaneous roar in the speakers. It was 9:30 PM Moscow time.

— Liftoff!



On May 15, 1987, the first launch of the "Energia" launch vehicle took place

A.A. Makarov jumps from his seat and clutches his head. V.E.

Gudilin waves his hand, as if seeing the rocket off into flight. The Chief's face is tense. What is he thinking at this moment?

For a few seconds, we observed the movement, precisely the movement, of the rocket on the television screens. Then only the report.

- Flight normal.
- First and second stage engines are operating normally.
- Side blocks separated.
- Flight normal.
- Pitch, yaw, and roll are normal.
- Fairing jettisoned from the spacecraft.
- Second stage engines are operating steadily.
- Flight normal.
- Second stage engines shut down.
- Object separated.

The faces of everyone in the control room immediately relaxed. V.E. Nesterov unhooked himself from the table, which he had held with his hands as if the success of the flight depended on it. Everyone jumped from their seats. They embraced. They felt like participants in a very majestic event. They were all heroes. They created and made this celebration themselves. What is the best reward for a rocketeer? Of course, flight. It gives such a feeling of satisfaction that cannot be compared with any awards.

I go out into the lobby.

— And you said it wouldn't fly, — I say to the head of the theoretical complex.

— I said that so as not to jinx it, — he grumbled in response. His face was grim. A familiar colonel with a flight assignment under his arm caught my eye.

— Where's Maksimov?

— He was in 322, — I reply.

Room 322 is the control room.

A.A. Maksimov exits the hall and goes straight to the colonel.

— Where should I sign?

— Here, — and the colonel opens the flight log.



Group of test leaders and assembly teams P.K. Bondarets, A.S. Gonchar, V.N. Chizhukhin, V.I. Kalakutsky, B.N. Filin, G.G. Romanov, S.S. Ershov (seated), B.S. Luzgin, L.N. Gaisinsky, M.M. Radko, V.K. Andreev, A.G. Matyunin, V.E. Nesterov, V.L. Nikolaev, V.V. Mashchenko, S.Yu. Prokofiev, N.E. Korzhenevsky, M.Sh. Rayanov, V.N. Osadchiy, V.D. Semenov

I was speechless with surprise. So, you, General, didn't sign the document before the launch, but signed it after the launch, when everything went well, I thought to myself. Well, well! The experienced A.A. Maksimov knew well what he was doing. Joyful, we rushed to the hotel to celebrate. Valentin Petrovich named the rocket "Energia." In the morning, B.I. Gubanov came to me. Angry.

— Let's go to the recreation area, I don't want to see anyone.

— What happened?

— Polukhin didn't perform.

— So what. That's not the main thing.

— That's what you think, not the state commission. I've already argued there. At that time, I couldn't imagine what a fly in the ointment this "Plus" object had put in our plans. The reason the object didn't reach orbit was an incorrect orientation system operation. It worked in such a way that the normally functioning boost engine produced almost zero boost impulse, and the object fell into the Pacific Ocean, like the second stage of the launch vehicle.

After the launch, we arrived at the "zero" mark. A stunning picture opened before our eyes. It was as if a rockfall had passed through the "zero" mark. Concrete slabs weighing about 5 tons were haphazardly scattered on the ground. But no damage to

communications was visible.

Later, in a film, we saw that at launch, the rocket tilted towards the spacecraft, then straightened out and went into space.

The roll occurred not over the launch opening, but next to it. As we used to say, it wagged its tail. The cause of this was quickly determined. And for the next launch, the stabilization autopilot was reconfigured.

We're flying to Moscow. In the cabin, on the sofa, Gubanov and Polukhin sit turned away from each other. An unusual silence in the cabin. No one wants to talk.

An hour passes.

— Let's go out, — the Chief says to me and V.M. Karashtin. We went to the back cabin of the plane. — Don't despair! And you, — he pointed at me, — must urgently prepare a resolution in which it is necessary to acknowledge everyone who worked. This is your business. Pour!

For a long time in Moscow, I walked around with a draft resolution to acknowledge the participants in this development. There was a wall in front of me. I went to V.P. Glushko.

— You see, not everything went smoothly for us. We didn't reach orbit.

— What does "Energia" have to do with it? It worked magnificently.

— Yes, there are no complaints about the rocket. But we didn't reach orbit.

I left empty-handed. I went to V.P. Radovsky for help, asking him to influence V.P.

— You see, if we hand out awards now, many won't get what they deserve. We need to wait for the launch of the orbital vehicle, — Vitaly Petrovich explained to me.

These thoughts, I understood, were also at the very top. So we, as they say, "missed out on the money." Many did not believe in the success, considering the first flight of the "Energia" rocket to be accidental. Here's what B.I. Gubanov would say about this much later:

— There was nothing accidental, nor could there have been, in the positive result of the first "Energia" test. The only accident could have been a failure.

DIGRESSION FOUR

It's sometimes strange to see how leaders bring along, in your opinion, not entirely capable people. Maybe even unintelligent ones. And you're left wondering: "How can that be?" I searched for explanations for a long time and, it seems, I found them. Any person, interacting with colleagues, gets to know them from all sides: from a business perspective, a personal one, and a social one. A certain opinion is formed about each person. They can already well imagine what their associate will do in various situations, how they might solve a particular problem, what they are capable of. Becoming a leader, they "pull" their comrades along, understanding well what each person can do and what can be entrusted to whom. This is how a team is formed. And getting into it from the outside can sometimes be simply impossible.

Members of this team, having a certain influence on the leader, very jealously guard against the intrusion of new members into their collective, and very jealously monitor the influence of new colleagues on the leader.

Everything is good in moderation. And if it turns out that a newcomer in their team has attracted more close attention from the leader, then watch out! They'll devour them! They'll set them up, so skillfully and cunningly, that the newcomer won't even understand why the leader's attitude towards them suddenly changed. Some team members do this due to a lack of intelligence, others for pension reasons, and still others out of vanity. And when joining a team, you rarely find someone helping you. But I know for sure that such people exist. And sometimes they don't care what is said about the newcomer; they look at their business qualities and understand that these qualities help the entire team and the leader move forward. Several times I found myself in the role of a newcomer and I recall these few with deep gratitude. I think that the cause only benefited from this.

TRIUMPH?!

The launch of the “Energia” rocket greatly spurred our shipbuilders. Chief designer Yu.P. Semenov literally lived in the Orbiter’s MIK (Assembly and Testing Building).

And the MIK itself was the fruit of his tireless activity. Arriving at site 254, where the MIK was located, he began with the most trivial demands on the builders, not only regarding deadlines, but also the cleanliness of the premises, the availability of working toilets, etc. Nothing escaped his gaze. He is one of those people who considers everything his own. He considered the enterprise his own, he considered the team his own, he considered the “Soyuz” and “Progress” spacecraft his own, he considered the “Salyut” and “Mir” space stations his own, and he considered the orbital vehicle his own. This determined his actions. He did not allow anyone to interfere in his production activities without his permission, and he jealously monitored ministerial officials from whom he received no effective assistance. His attitude towards his comrades, his ability and desire to help them in their difficult moments, were highly valued by employees and co-contractors. These qualities led to him later becoming V.P. Glushko’s successor — the General Designer of NPO “Energia.”

He “handled” matters related to the orbital vehicle at daily operational meetings with his deputy N.I. Zelenshchikov. The office was covered with dozens of posters listing unresolved issues and missing components. Completed items were marked with a red pencil. And anyone who didn’t meet the deadline was simply “smeared against the wall.” Each item had a responsible person assigned, and it was immediately clear who was working and how.

More than a dozen versions of mathematical software had to be developed at NPO AP: the ship’s flight was planned to be fully automatic, but subsequent deviations in the systems led to new versions.

The management also got their share: V.L. Lapygin, Yu.V. Trunov, V.V. Morozov, and their colleagues. I think this requires a separate narrative, both about the managers and about our colleagues from NPO “Molniya.”

But let’s return to site 112. Deputy Minister V.Kh. Doguzhiyev closely monitored the assembly of the product. The assembly pace largely depended on the supply of components from Samara. I had the impression that the entire factory, as during wartime, was working for victory. The factory director A.A. Chizhov organized

production very skillfully and demandingly. People worked extended shifts, without days off. They had good earnings and supplies. Hence, minimal delays in deliveries. Having their own planes, the factory workers literally sent their products “warm” to the TK (Technical Complex).



Nina Ivanovna Osmyslova and Grigory Yakovlevich Sonis

Only a well-educated, knowledgeable, and strong-willed person could lead such a “colossus” as the “Progress” plant — which Anatoly Alekseevich Chizhov was.

The assembly was not without incidents. During pneumatic tests of the hydrogen tank, a 40-meter tunnel pipe extended from it. This pipe runs through the entire tank, and inside it is a consumption pipe through which oxygen from the upper tank enters the engine. So, due to poorly secured flanges, the pipe moved out of the tank, stretching the compensating bellows.

There was no repair technology at the TK. And the factory technologists had not anticipated such a case.

What to do? Return the tank to Samara? After all, all the tooling for mounting the pipe was there.

Grigory Yakovlevich Sonis and Nina Ivanovna Omysova (?) spent difficult nights developing a repair technology and found a way to restore the tank. The fact that all this led to a deviation from the work schedule was no longer paid attention to.

Slowly but surely, the rocket assembly was nearing completion. The aft compartment and the inter-tank compartment were already ready. This meant that the end of mechanical work was becoming tangible.

Block A had already moved to the fourth bay of the MIK. And the deputy director of the experimental machine-building plant, Yu.I. Lygin, kept urging his subordinates. He had already begun preparing blocks for the next rocket, and along the way, as if by chance, he built an entire dacha town on the banks of the Syr Darya for his employees to relax. Thanks to V.D. Vachnadze, this town became known as Podlipki-Dalniye in honor of the settlement Podlipki-Dachnye, as Kaliningrad was once called.

The most surprising thing was that no one ordered Yuri Ivanovich to create this miracle in the steppe. He was confident that the cosmodrome, and with it his people, would live there for a long time, and they, like all employees on the mainland, also needed normal living conditions.

Finally, the central tank was also assembled. Something clutches inside. When you embark on a new stage, let's say, in our case, the launch of 6SL, it seems that there is no harder task than to pass this stage. All nerves are strained, a thousand doubts gnaw at you — what if?

But the stage passes, and it seems: what was so special? Why were you nervous? Everything seems so small and ordinary that sometimes you wonder why you argued for nothing, why you spoiled each other's mood. What fools!

But the next stage begins. And you forget about the fools, and everything repeats itself: again, the most important stage is before you, again you have doubts, again your nerves are not in order, again arguments, and so on.

Thus began the next stage in the ISS “Buran” program for us — the flight test stage of the orbital vehicle.

The central Block C also moved to the fourth bay. Assembly according to the schedule — ten days with two-shift work and two weeks of testing.

The orbital vehicle was two to three weeks late for assembly. But something in the world is interconnected, interdependent; some cannot get ahead while others fall behind. Just as we, the rocket engineers, relaxed and wanted to rest a bit, i.e., work in a normal mode, no! The issue of fragments surfaced. It was discovered that during the activation of pyrotechnic separation devices in the upper connection nodes of the side blocks with the central one, small fragments were formed. They would enter the oncoming flow and could damage the thermal protection tiles of the orbital vehicle.

If they can, they will definitely damage. This could not be allowed. A new fragment-free separation unit was urgently designed, tested on a special stand, new standard units were manufactured, and delivered by plane to the test site. This cost Igor

Efremov many sleepless nights. He was personally responsible for the design to the Chief Designer.

The new units arrived, but the package was already assembled. How much we didn't want to disassemble it! But there was nothing to be done.

Now it was our turn, the rocket engineers, to be in a difficult position. I approached N.S. Shurakov:

— Well, what are we going to do?

— What?

— Are we going to be “red-faced” now?

— It depends on how we work.

— And what do you think will help?

— A bonus.

— And how much?

— A good one. Based on salary — and we'll go through everything in ten days.

— Agreed.

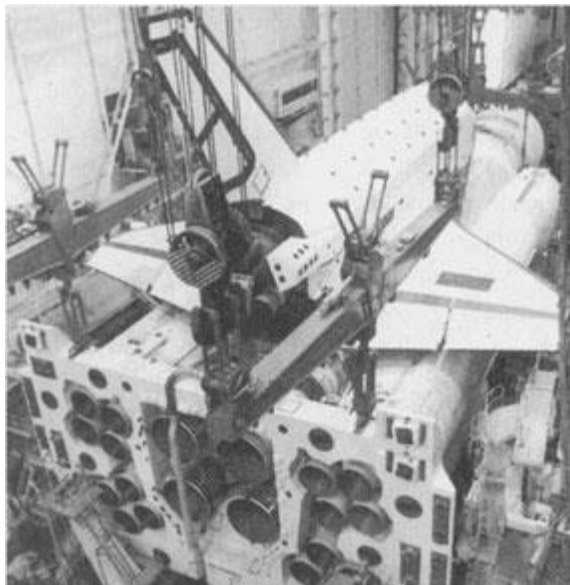
I went to the Chief. It was good that he had his own fund at the TK and was able to arrange for the bonus to be processed and received within an hour.

Boris Ivanovich listened, asked for the schedule, and gave us those ten days for the overhaul.

It was a matter of honor for the rocket engineers not to fail. We organized integrated teams with the customer and designers, established engineering control of operations, and work began in earnest. We finished exactly in ten days. And there was a bonus.

The beautiful orbital vehicle rolled up on the transport unit. The most crucial operation began — installing the orbital vehicle onto the rocket. The shipbuilders, led by Chief Designer Yu.P. Semenov, did not leave their brainchild for a minute. Formally, the ship was handed over to the “Progress” plant for final assembly, and the “Progress” plant was responsible for its safety and installation.

But one can also understand the people who worked with the ship for long months, months of intense labor, sleepless nights: what if the new assemblers do something wrong?!



The “Buran” orbital vehicle being installed on the “Energia” launch vehicle



Overloading the “Energia-Buran” system onto the transport-erector unit

During every operation, whether it was docking the lifting traverses and lifting the orbital vehicle, neither the Chief Designer, nor the lead engineer Yu.K. Kovalenko, nor the factory workers V.V. Moskvina and V.P. Kochka, nor the representative of NPO “Molniya” A.A. Motrov, left its side.

With a certain pain in their eyes, they looked at it: would it ever return to them?

A small table was placed next to the orbital vehicle, on which samples of the thermal protection coating were laid.

Touch, feel, look, but do not touch these tiles (and there are more than 30,000 of them) on the ship itself. The tiles, capable of

withstanding temperatures up to 2000°C, were very fragile, and the slightest mechanical impact would render them unusable.

The price of each tile was equal to an engineer's monthly salary. Interest in them was great. So, to satisfy the curious, samples were laid out in a row.

The assembly cycle for the rocket and orbital vehicle is short. Three days are allotted for this, and another week for joint checks. Then the entire assembled complex proceeds to the assembly and fueling complex. There, the orbital vehicle is fueled with high-boiling components.

A few days pass, and the entire behemoth — the rocket and the orbital vehicle — slowly rolls out of the MIK on the erector to the pad in front of the building.

A solemn formation, a group photograph, and the whistle of the locomotive that pulled the rocket to the final stage of flight preparation — to the launch pad.

The entire complex came under the jurisdiction of the military testers of the 6th directorate of the cosmodrome. The commander of the directorate, V.E. Gudilin, finally reported that all systems of the launch complex were ready to receive the product.

Combat crews were formed, and their actions were defined for everyone. Everything seemed to be checked and ready.

Once again, the technical leadership gathered for meetings to analyze the readiness of the systems. Now both Chief Designers conducted them together, as V.P. Glushko was absent due to illness. So, our Chief Designers had to take full responsibility.

Hundreds of emergency situations that could occur during preparation were reviewed, many of which led to the halt of further work. All possible system failures were considered, and further actions were determined, with algorithms for each operator's work outlined.

Everything was aimed at saving both the rocket and the orbital vehicle in any emergency situation.

But when an additional analysis was conducted before the launch, and the options for “false” alarms were taken into account, we realized — we would never launch.

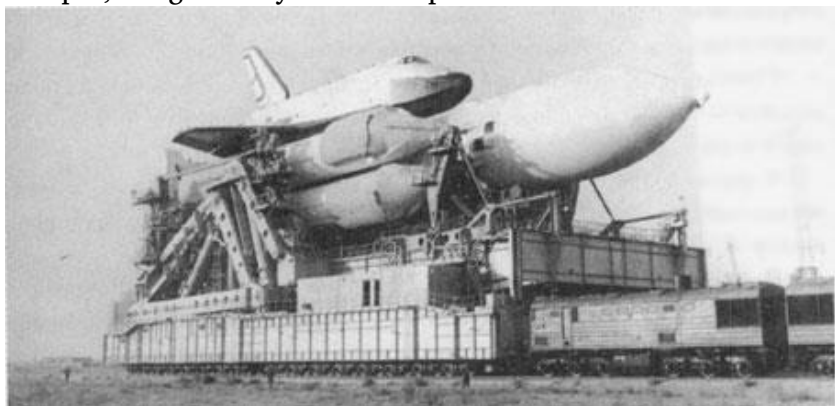
Sleepless nights again. We began to “clean up” the emergencies and reduce, on paper, their prohibition on subsequent work.

Many parameters were removed from the particularly dangerous category. But even the remaining number of such parameters could halt the preparation process at any moment, including due to false alarms. The product was installed on the launch pad. The mixed combat crews of military and civilian personnel, having gained experience working on mock-ups, acted in

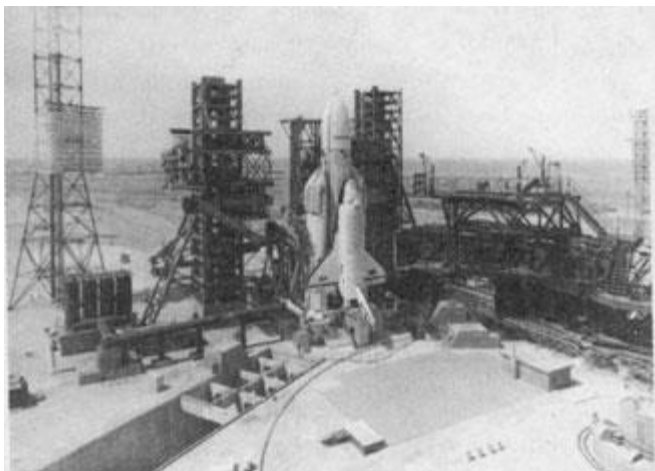
unison.

The final operations began with a meeting of the technical leadership, then the state commission, and approval for fueling was received.

Everything seemed to be checked. But then someone remembered, what if we put souvenirs in the orbital vehicle? Like, envelopes, badges. They would be priceless later.



Transportation of the “Energia-Buran” system to the launch complex



Installation of the “Energia-Buran” system on the launch complex

But the superstition deeply ingrained in the creators of space technology took its toll. Yu.P. Semenov categorically forbade even thinking about it. Many rocket engineers shared his opinion. So, these envelopes and badges flew back to Glavkosmos, never having been in the orbital vehicle.

Nitrogen preparation was carried out in advance. The launch was scheduled for October 29, 1988.

We always loved gifts for holidays, especially for the October Revolution Day — November 7. The most crucial moment arrived.

Fueling and launch. All cosmodrome services, search and rescue service, ground measurement points scattered throughout the Soviet Union, floating measurement complexes, control centers were brought to readiness. Thousands of people took their workplaces. But all eyes were directed at Baikonur, at site 110. How would the system launch? Many did not believe in success, many doubted — luck cannot strike twice, many felt a certain indifference after tense days. But no one was calm anymore, everyone was waiting.

Again, the launch directors are at the table. These are the commander of the combat crew V.E. Gudilin, technical director B.I. Gubanov, technical director responsible for the readiness of the orbital vehicle Yu.P. Semenov, test director V.M. Karashtin, shift commander of the combat crew N.I. Kovzalov. Behind them is the top leadership headed by the head of the Military-Industrial Commission I.S. Belousov: A.A. Maksimov, V.Kh. Doguzhiyev, heads of industry institutes.

The preparation procedure is scheduled down to the minute, and how much we wish they would pass faster.

Fueling was completed, and we moved on to the thermostatic process — this process involves replacing the “warm” cryogenic component from storage with a “cold” one. Thus, new portions of the “cold” component prevented the component in the tank from heating up.

Reports of readiness for launch from all systems involved in the preparation began to arrive.

That's it. Ready! A decision must be made.

— I authorize pressing the “Launch” button, — the Chief gave permission for the further process.

— Press the “Launch” button, — the command from the commander of the combat crew, General V.E. Gudilin, rang out.

— Understood, press the “Launch” button, — replied the fifth person over the loudspeaker.

Many immediately get the feeling that after this, the rocket takes off.

In reality, there were still a full 10 minutes left until the launch of the “Energia-Buran” complex.

All processes were transferred to the ground computer. The most complex, most intense operations remained, related to the separation of ground communications, the closing of valves on the product by the engine launch cyclogram (and there are eight of them on the product), switching to onboard power, etc., etc.

The entire cyclogram of the last 10-minute operation is scheduled down to tenths of a second. And naturally, a human is no longer able to grasp, let alone analyze and make a decision.

Therefore, everything is planned in advance and programmed into the ground and onboard computers. All possible emergency situations are also programmed. The launch process began. These 10 minutes make everyone somehow gather themselves; drowsiness disappears somewhere (we are lucky again — the launch is at night).

9 minutes passed. One minute remained and...

But what is this?!

On the display, in large letters: APL — Abort Launch.

Everyone recoiled from the screens and turned their gaze to the Chief — B.I. Gubanov. He sat calmly, waiting for reports. The abort could have happened due to many parameters. Including the ship's. Yu.P. Semenov quickly went to the orbital vehicle preparation and control room. He returned a few minutes later.

— I'm not to blame, — he said, — the abort was not our fault. The product without thermostatic control can only remain on the launch pad for a limited time. And how much we don't want to drain it to repeat all the preparations again.

But some decision had to be made! Our manager from Kharkov, V. Strashko, arrived, bringing a printout from the machine.

The picture began to clear. The APL occurred 53 seconds before lift-off contact due to not receiving a signal that the aiming plate had moved away from the product.

Television cameras showed that the truss, to which the plate was attached, had moved away from the product. How could this be? There was only one immediate conclusion: the plate's lock had failed. An urgent meeting of the technical leadership at the "first's" table. Continuing, i.e., repeating the launch cyclogram, was not possible. There would immediately be a "reset" because signals from the plate would not enter the circuit. A detailed investigation was needed, which meant the product had to be drained. The decision was made.

— Prepare to drain the product, — the first's command rings out, — the launch is postponed for 10 days.

I thought to myself, "How did he determine these ten days?" State commission meeting. I go with B.I. Gubanov.

— Who should we appoint as chairman of the accident commission? — he asks. — Perhaps Ya.P. Kolyako? — He immediately answers. — No, he won't unravel it. Let's propose you. Do you object?

— No, — I reply, my heart skipping a beat.

The meeting took place, a chairman was appointed, and a deadline was set — three days to analyze the situation.

I gathered everyone who could in any way influence this

incident into the commission. These included representatives of the general developer of the launch complex, managers from Kharkov, designers — developers of the plate and its retraction mechanism, manufacturers of hydraulic systems, representatives of the main plant, and the customer from GUKOS.

We gathered in one of the rooms at the command post. The product was still being drained. And we were not allowed to leave the command post.

— I address everyone regarding this incident, — I said to those gathered, — I ask you to proceed from one premise — everyone looks for the cause of the APL within themselves. I strongly ask you not to prove that you are not guilty. In that case, we will not find the cause.

Everyone agreed with this approach.

— Let's create several groups that will thoroughly examine the plate itself, its locks, break down the entire cyclogram of this process to nanoseconds, investigate all ground electrical and hydraulic systems, analyze the kinematics of the retraction, and review all the mechanics of the retraction mechanism.

No one objected. I gave them one day.

— The next meeting is tomorrow at 7 PM in the MIK, — I concluded. But I was so eager to see that ill-fated retraction spot that I couldn't wait and went to the product during the evaporation of cryogenic component residues. I learned that during the draining of kerosene in one of the side blocks, the process was very slow. The technical leadership created another commission for this, led by M.I. Galasy from Yuzhnoye Design Bureau.

Under the product, I saw a group of our TV operators. Through their camera, I looked at the plate's location with the maximum possible magnification, bringing the lens as close as possible. The service tower could only approach about four hours later, at the end of the evaporation.

I saw nothing seditious on the TV screen. This immediately puzzled me. For some reason, I thought that the groups would not find the reason for the plate not retracting.

When the service tower approached, we climbed with the commission to the platform directly to the plate's attachment point. Everything was clean. No tears, no scratches.

We gathered in the evening for the debriefing. The group leaders gave oral reports. Everyone reported that everything was in order. My premonition was confirmed. I asked everyone to provide written conclusions.

I report to the Chief.

— Look in the control system, — I receive instructions from

him, — make sure you don't let the designers down.

The next day, having received the written conclusions, I realized there was nothing to report to the state commission. My head was spinning. How could it be: the plate should have moved away in a minute, but it thought and thought and moved away with a forty-second delay. This was enough to trigger the emergency signal. What held it for 40 seconds?! We dissected the entire structure. We saw nothing alarming in the drawings. I went to V.Kh. Doguzhiyev, the chairman of the state commission. I asked for a couple more days. He allowed it. But my head was spinning, I mentally worked through every system, and nothing led to even a hint of a possible cause.

For three days, my head was occupied with this search. I stood by the assembled product No. 2L and looked at this plate. I wondered, what exactly held the plate for 40 seconds? What? What if I pull the plate off this product and look at the force of this pulling? I approached the chief technologist G.Ya. Sonis.

— Do you have a dynamometer?

— Which one?

— Well, I want to pull the plate off 2L.

— I'll check now.

He made a call.

— Yes, we have one.

— Grigory Yakovlevich, hook it to the crane and lift the plate. I want to see the forces. It was evening. The bosses were gone.

Everything was quickly organized. They started lifting. The dynamometer showed a force of 1 tf, but the plate stayed in place. 2 tf — the plate stayed in place. 3 tf — this was already an order of magnitude greater than specified in the technical requirements for the retraction mechanism, but the plate stayed in place. And only when the force reached 3.5 tf did the plate detach. The cause was immediately determined. The dust-proof rubber seals, located on three blenders, created such a resistance force.

— This is the reason in our case, — I tell the branch director N.S. Shurakov, — apparently, you didn't lubricate the blenders. Hence such strong friction.

His eyes widened. After all, he had to answer to the leadership, and this "smelled"... He went to report to the Chief that he had found the cause. And in his office, my lead engineer A.N. Voronov was explaining, based on his analysis of the control system, what was happening during each cycle of the computer. From the report, it followed that the blame could not be placed on the control system. And then I entered the office. I immediately understood that, parallel to me, the Chief was checking versions through

another channel.

— The rubber sealing ring on the plate is to blame, — and I report to him in detail about the experiment in the MIK.

— What do you plan to do?

— We need to confirm the version on a mock-up.

— Then confirm it, — he said sharply.

As much as I didn't want to, I had to admit that it was a design flaw. Hence the Chief's sharpness. I went to N.S. Shurakov. He, calm and smiling, opened documents before me.

— The factory, as you know, works according to the Chief Designer's documentation, and there's not a word about this in the documentation. So the factory is not to blame.

— All right, Nikolay, you're right, help set up the experiment.

— And what is needed for this? — interjected the incoming head of the main department P.N. Potekhin.

— We need a transitional compartment, a plate, seals, and crane tension with a dynamometer. We need to simulate the failure, otherwise they won't believe us. And I won't even believe myself.

— Everything will be done by evening.

I went to look in the MIK, and already the inter-tank was moving to the test site on cranes. Well, well, I thought. Earlier, such an experiment could have been organized in three or four months. But here, not even an hour had passed before work began in earnest on a verbal instruction. This is what they say, the fried rooster pecked.

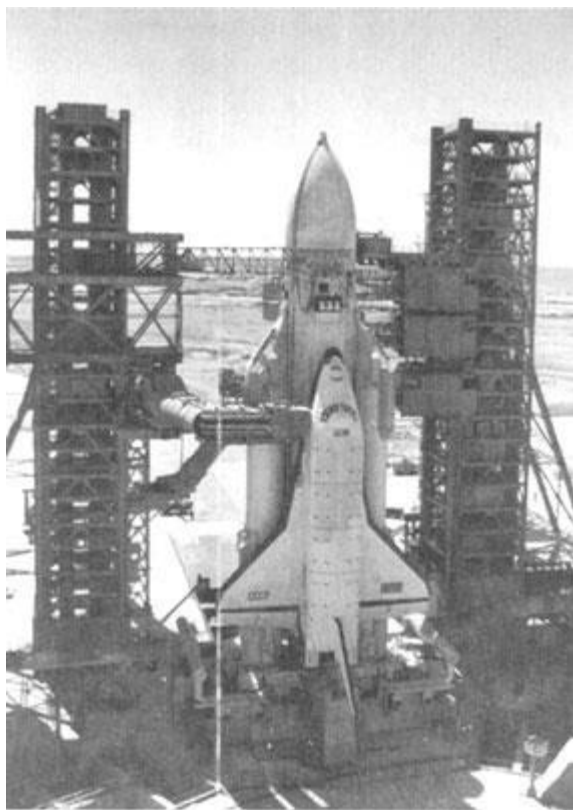
Late in the evening, everything was assembled; now it was necessary to give it a hold, and then a firing. Since the next day was the November 7 holiday, I suggested doing the firing on the morning of the eighth. We needed a little rest.

Designers G.G. Romanova had already drawn a new sealing unit, and in Samara, they quietly manufactured high-power plate pusher-locks, but everything depended on the experiment. If the plate remained on the blenders, we would confirm the version and need to refine it. If it detached, we would look for other reasons.

In the morning, so many people gathered at the inter-tank that I had difficulty making my way to the section chief to give the command.

Exciting.

— Proceed with the firing.



“Energia-Buran” on the launch complex

Pressure is applied. The locks opened, the plate shifted, but it did not detach from the inter-tank; it remained on the blenders. Which was what needed to be proven.

New sealing units have already been installed on the product. In principle, they excluded such a situation. Now, a report to the State Commission and we can proceed with a repeat launch. The launch was scheduled for November 15, 1988. But the day before, S.A. Petrenko approached me and showed me calculations. From them, it was clear that there was a combination of parameters under which the plate could get stuck on the studs. This was after all permissions for fueling had been given. I had to go to the Chief. He didn't want to hear anything:

— All decisions have been made!

But we, as he himself liked to say, sat at the table with the stubbornness of drunks. Petrenko, Nesterov, Chizhukhin.

— Boris Ivanovich, this is necessary, — V.N. Chizhukhin persuaded him.

— I'm going home, — the Chief stood up, demonstratively dressed, and began to leave the office. We sat.

— I have to close the office.

We sat.

— I said I wouldn't sign another decision.

We sat.

He couldn't take it anymore. Dressed, he sat in the armchair. He picked up the direct phone to the minister.

— Vitaly Khuseynovich, I have some unfortunate designers here, they want to do more work. Can you listen to them? But I think after this, Petrenko should be fired.

Consent was given on the phone, and we all trooped to the minister.

— Report, — the Chief ordered S.A. Petrenko.

He hung a small poster and began to explain that the pusher-locks needed to be strengthened.

— But where do we get them? They need to be made, — said Vitaly Khuseynovich.

— We've already made them, tested them, and brought them.

— See their work? They knew about their flaws and kept silent, — the Chief interjected.

— How much time for replacement?

— About two or three hours, — answered Markin A.A., Petrenko's deputy for testing. ,

— Proceed.

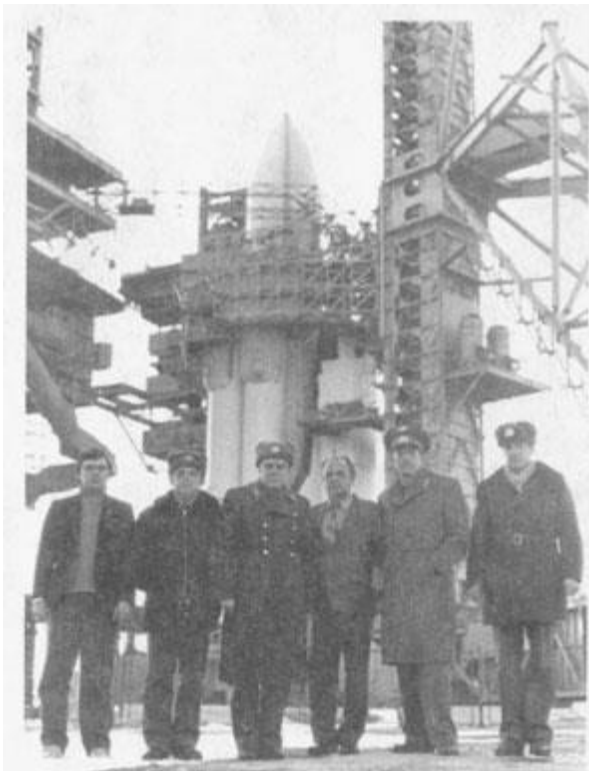
We left.

— You started this, you sign this decision yourself. And keep in mind that you are personally responsible for its execution and control, — the Chief threw at me. He got into his car and left to rest.

And we, having breathed a sigh of relief, went to the launch pad to change the locks.

The weather forecast was not the best. They promised a sharp deterioration in the weather, rain, strong wind. The weather seemed unwilling to let our brainchild leave the cosmodrome.

The Chief gathered his colleagues and began to ask one question: who thought what — to launch or not to launch. Practically everyone spoke in favor of launching, well understanding that something could happen that would postpone it altogether. Only one of the always-right ones advised against it.



A few hours before the launch of the “Energia-Buran” system. In the center are N.S. Shurakov and V.N. Chizhukhin

The Chief, without expressing his opinion, went to the minister’s office, where all the technical leadership had gathered.

Outside, the weather was changing before our eyes. The sky became overcast, it suddenly grew cold, and a fine rain began to drizzle. This threatened the formation of an ice crust on the thermal insulation of the orbital vehicle and the rocket. And if its thickness exceeded 2 mm, the launch had to be postponed.

— What icing do you predict? — Gleb Evgenievich Lozino-Lozinsky asked our Chief.

— 1.7 mm, — B.I. Gubanov replied.

— That’s acceptable, — said Gleb Evgenievich.

— We can launch, — gave permission for the launch the Chief Designer of NPO “Molniya,” responsible for the design of the orbital vehicle’s airframe.

He was supported by the chief of the orbital vehicle, Yu.P. Semenov. The others joined their opinion.

The Minister gave permission for fueling. And everyone together went to the command post. We saw nothing supernatural in the weather outside. And how do meteorologists know what will happen? Usually, their forecast was three or four hours late. Our

Chiefs were counting on this. However, I still don't understand how they named those ill-fated 1.7 mm.

БЛАНК ФП

(данные о фактической погоде)

Время: 5.00
Дата: 15.05.88

1. Срок наблюдения 4.30
2. Облачность:
количество 10 баллов
форма фибрильно-дождевая, слоисто-кучевая
высота нижней границы, км 550 м
3. Явления погоды туман
4. Метеорологическая дальность видимости, км 10
5. Ветер у земли:
направление, градус 110°
скорость (с 2-х минутным среднением), м/с 15 м/с
порывы, м/с 19 м/с
6. Температура воздуха, °C +8,8°C
7. Атмосферное давление на уровне ВПП, мм 995,3 мм
8. Длительность заморозков за последний срок до
высоты 25000 м через 500 м (см. приложение)

РРМ036 *[Signature]*

Weather forecast data for the rocket launch on May 15, 1988

№ 11284 AB-4

ШТОРМ-ПРЕДУПРЕЖДЕНИЕ № 4

1. В период с 07:00 часов до 12:00 часов.

2. По району (территории) Южная часть территории

3. Ожидается:

Ветер с северо-востока
600-1000 м

Увеличение скорости ветра
9-12 м/с с северо-востока

до 20 м/с

4. Время составления 08:15

5. Время вручения 08:17

Подпись составителя

Подпись получателя

In the control room, there was a working silence. Everyone was in their places. Volodya Rachuk and I were sitting together again. Again, this tedious process of fueling, thermostatic control, but everything was on schedule. It was time to press the “Launch” button. At that moment, a lieutenant colonel from the meteorological service approached the table of the combat crew leader — the launcher — with a marching step, his boots clanking on the floor tiles. Everyone watched this spectacle with surprise.

— Comrade General, may I address you?

— Address me.

— I must hand you a storm warning for your signature.

— Where do I sign?

General V.E. Gudilin signs.

— You are dismissed.

The lieutenant colonel salutes, turns smartly, and leaves just as loudly. The Chief quickly finds Ya.E. Aizenberg, clarifies the theoretical load margins, and calmly sits down at the table.

The first command sounds:

— Press the “Launch” button.

— Understood, press the “Launch” button.

Again, the oppressive tension changed the faces of the operators and management. We approached the minute before lift-off — contact of ascent. On TV, it was visible that, in accordance with the standard cyclogram, the aiming plate had retracted. It became easier. Rachuk shakes my hand.

Then the process proceeded with a countdown in seconds.

— Second stage engines ignited!

— First stage engines ignited!

But the information over the loudspeaker lagged behind the events on the TV screen. We had already seen the entire 2400-ton behemoth quickly flash across the screens.



May 15, 1988, saw the first launch of the “Energia” launch vehicle with the “Buran” orbital vehicle

Further on the monitors, sensor readings were displayed, and the voice of the operator, Colonel Tolstykh, reported on the flight.

- Engines are operating stably.
- Flight is normal.
- Pitch, yaw, roll — normal.
- First stage engines shut down.
- First stage blocks separated.
- Second stage engines are operating stably.
- Second stage engines shut down.
- Orbital vehicle separated.

The rocket engineers had done their job. Now it was the shipbuilders’ turn.

— Congratulations, — Yu.P. Semenov quietly says, — now I’m on my own.

The Chief’s face was somewhat bewildered. I wonder what he’s thinking about? Probably, during the time the ship was out of sight, he mentally ran through all the ship’s systems.

But here are the first reports. Communication is back. The ship is in orbit!

This means that the combined propulsion system also worked well with the cryogenic fuel components. There had been the greatest concerns about it. After all, there had been problems during bench testing.

The ship went into its second orbit. Now it had to perform a lateral maneuver after braking and land at the airfield specially built for it a dozen kilometers from the launch site.

Anxiety again. The flight is automatic! There's no way to help from Earth.

— The ship has entered the landing cylinder!

It sounded so joyful and reassuring that I thought: now it will definitely land.

A MIG-25 had already taken off to meet it.

And then a black dot appeared on the screens.

It's him!

He majestically approached the landing site, as if letting everyone know: don't worry about me, I won't let you down.

A light smoke under the landing gear.



Landing of the “Buran” orbital vehicle

Everyone froze.

The ship deployed its drogue parachute and smoothly stopped in the middle of the runway.

That's it!



S.A. Afanasyev, B.I. Gubanov, I.S. Belousov, G.N. Gromov, N.I. Zelenshchikov, Yu.P. Semenov and others near the landed orbital

vehicle

A momentary silence and a storm of applause. Operators and leaders jumped from their seats, hugging and kissing. Many cried: both civilians and military, shyly wiping away tears. The feeling of the significance of what had been done literally burst from everyone. They rushed to congratulate the chiefs — Yu.P. Semenov and G.E. Lozino-Lozinsky, and they, haggard, could not contain their joyful feelings, thanked everyone, and also congratulated them.

We got into buses and rushed to the airfield. We stepped onto its field and realized that the meteorologists' warnings were not in vain. The wind ripped off headwear, literally blowing us off our feet. And it, the beauty, stood precisely on the central mark of the runway.

Oh, those managers! They conquered the weather after all!

We inspected the ship. Only four tiles had fallen off the hull. This practically could not affect even a second flight.

An interesting fact: the “Buran” parachute was never found. Either the wind carried it into the steppe, or it was torn to pieces — as a memento of that significant day, November 15, 1988.



Near the “Buran” spacecraft after its flight

We went to the rally. Everyone spoke breathlessly about the highest achievement. Joy, joy, joy.

A revelry began at the hotel. And in a surge of immense enthusiasm, our colleague from Leningrad, Doctor of Technical

Sciences G.S. Potekhin, delivered his poems to us in an hour:

Winter has already breathed upon us
With its whistling cold,
And gloom has shrouded the sun...
But we all stand at the launch pad!
It's time for the "bird" to flutter out
From earthly forces into the darkness of worlds...
All failures and bumps
We have plowed through — good health!
And it seems everything should work!
And with one breath
We get back to work —
Will it really not fly again?!
So difficult the path! And so immense!
We are so tightly bound by everything,
Like neurons in a thinking brain...
And we all have one goal!
We have already named the date,
And the countdown has begun in hours...
But the wind from the misty gray distance
Again tipped the scales back...
And again a test of nerves!
To launch or not?! For a storm is coming!
And this time the ascent with the "bird" is the first!
But courage calls us forward...
Here's the moment — nerves gathered into a knot!
Flame, roar, smoke rose...
And from it comes "Energia,"
And with it — "Buran"... Hooray! We're flying!
But this is only half the battle —
We repeated the ascent again!
Now the "bird" must truly
Show its intellect to all!
And moment by moment, hour by hour
We follow its orbit!
And the pride in this flight of ours
Grows brighter and stronger in our souls!
But how will it pass from there?!
Through the plasma's heat and the complexity of trajectories?!
And now a miracle is happening —
It is visible,
coming towards us...
And how beautiful is the return
Of the creation of mind and hands!...

And the elegance of the landing!...
Hooray! The end of all our torments!
And a thunder of applause erupted in the hall!
We applaud ourselves!
Success!
Victory!
Happiness is near!
We are all flying into it now...
So let's turn and look
At our entire 15-year journey!
A path of disappointments and perseverance,
Struggle,
recognition,
victories...
And let everyone today say
Thank you to everyone who was nearby,
Who by deed, knowledge, thought, glance
Accomplished this miracle!!!
Today's holiday is not accidental!
It's time for all of us to say: "Health, new strength
we wish
And new difficult tasks! Hooray!!!
Baikonur, November 15, 1988

Joy overwhelmed everyone who participated in this grandiose event. It seemed as if everyone had touched something majestic, enormous, contributed to this endeavor, gave all their energy, and was proud of it.

It seemed that Moscow would greet us as heroes and give due credit to every participant.

The flight of "Energia—Buran" showed that our country also has industrial potential, no less than that overseas.

We began preparing grateful Resolutions of the Government and the Central Committee of the CPSU on allocating valuable gifts to participants, on selling cars, which at that time were difficult to buy. We prepared draft Resolutions on awarding Lenin and State Prizes, decrees on awarding orders and on conferring the titles of Heroes of Socialist Labor.

This was also not an easy job. We had to walk the corridors of power. We managed to "push through" some things. I can say with confidence that the last title of Hero of Socialist Labor was awarded precisely for work on our topic.

But then something broke in the awards mechanism, and many active participants in these events were left without awards. But the feeling that they had solved a complex technical problem, the

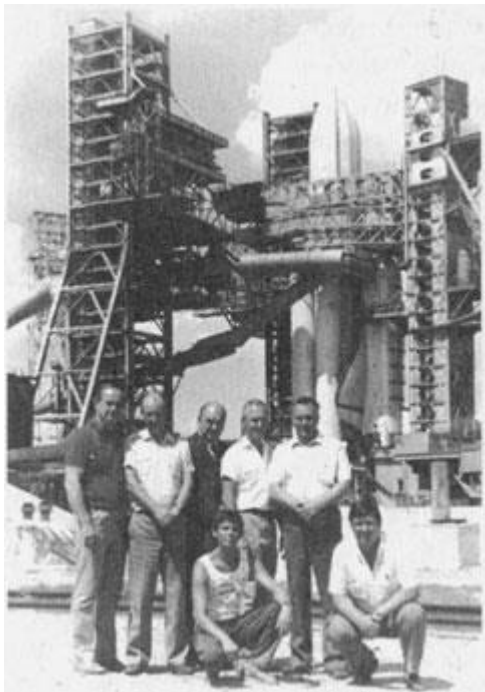
feeling of pride for what they had done, was the best reward for them.

LAST CHAPTER

The holidays were over. What we had achieved gradually began to fade into the background. The collapse of the Soviet Union, the loss of cooperation, and the entry into the market began to change the principles of approaching such great events, in our understanding, as the launch of “Energia-Buran.” Thoughts of immediate profit became dominant. State funds began to migrate to private structures. And these, naturally, could not handle such a project. Moreover, expecting profit from Buran launches was problematic. It is known that only communication satellites are profitable in space, and the Energia-Buran system was far from the optimal means of launching such satellites.

Attempts were made to introduce 600 cutting-edge technologies developed for the project into industry—it didn’t work.

Somehow, all our co-executing enterprises suddenly became impoverished, and now at meetings, words like: “We need to wait it out,” “We need to survive” are heard. These words only deter people from seeking new firms, new orders. These slogans again encourage reliance on state support. But the state has its hands full with problems. This is where young, energetic guys are bustling about. But these guys are no longer in the once prestigious industry, but in today’s prestigious banks.



Standing at the launch complex are: K.K. Popov, V.D. Semenov, A.A. Rzhanov, L.G. Firsov, V.M. Filin, and others.



Group of leading designers of launch vehicles: A.N. Voronov, S.S. Ershov, V.M. Filin, S.Yu. Prokofiev, A.V. Tarasov (seated), V.A. Zadeba, S.N. Zakharov, K.K. Popov, O.N. Sinitsa, S.I. Kozubenko, G.S. Ryabtsev, V.S. Firsanov (standing)

The time came when the word “engineer” became synonymous with poverty. Engineers, who had dedicated the best years of their

lives to a cause their Motherland considered extremely important and necessary, began to suffer from malnutrition and desperately sought any job, even if it was low-skilled and unprestigious, but one that allowed them to feed their families. And the smartest people, highly skilled specialists, went into commerce. All of them recall their beloved work with pain in their hearts, all their thoughts are in creation, and they tell you: call us, and we will return! Give us work, a salary, and you will see that today no one can do it better than us!

The most offensive thing is that friends, colleagues, with whom you went through a difficult path, created “Energiya-Buran,” lost themselves and do not even imagine how to get out of this modern situation.

Three Buran spacecraft and two assembled Energiya rockets are laid up at Baikonur. There is no work for them. They are used as museum exhibits of our former greatness.



Participants of the operational and technical management meeting on launch vehicles: V.P. Klippa, A.N. Voronov, V.N. Panarin, V.M. Filin, V.N. Bodunkov, O.N. Sinitsa, I.V. Zemskov, A.V. Tarasov (seated), A.M. Shcherbakov, V.V. Mashchenko, S.S. Ershov, V.T. Khaspekov, A.N. Shorin, V.V. Kudryavtsev, S.N. Zakharov, K.K. Popov, G.I. Belova, V.A. Zadeba, A.N. Sofiysky, A.A. Zhidyaev, N.S. Semina, Yu.A. Karpukhin, G.S. Ryabtsev, S.I. Kozubenko, S.Yu. Prokofiev, M.K. Ivanov, P.A. Avdeev, V.S. Firsanov (standing)

And numerous foreigners, who come to Baikonur to watch the launches of Soyuz and Proton rockets, click their tongues in admiration. Rockets that have served our cosmonautics faithfully and truly for 30 years. The elemental base is no longer the same, and we need to move to a new, more modern level of rockets, such as Energiya, Zenit. But their production mechanism is deteriorating

before our eyes. Urgent “injections” of the necessary amount of money are needed. But the country does not have the means for this. And only joint international projects help out. And today it is not surprising to meet colleagues from abroad with video cameras and cameras in our once secret assembly shops. Now the main thing is not to reveal know-how, and there are no secrets anymore. Our thinking has changed, the state’s attitude towards space has changed, public opinion has changed, the media do not extol our successes, but increasingly talk about our troubles, thereby as if emphasizing that this is the absolute truth. The work of an ordinary worker has become dishonorable, and entrepreneurs are all being promoted. But it is unclear what these entrepreneurs will do if there is no product.

But I don’t want to end the narrative on such a sad note. And how I want to believe that new projects, such as the creation of national space communication systems of a new generation, our efforts, combined with leading firms in the world, will allow us to enter the global market for space services, using, say, sea launch facilities. I also want to believe in space settlements, which E. Tsiolkovsky dreamed of, and in the wisdom of people who will finally understand that the most advanced technologies are born on the edge of the unknown and the known.

But even more, I want to believe that we have passed the minimum extreme of our attitude towards cosmonautics, and my comrades will gain confidence in their work and create the best examples of rocket and space technology in the world (as it has already been) and will receive such satisfaction from their work that they will forget this “dark” period of our lives.

And I want to bow low to all those who have not lost faith in our technology, who are still creating today, who are looking for new ways of its development, who have overcome themselves and rethought what is happening.



1992. Five years later, a meeting of participants in the launch of the Energia carrier.

I would like to thank my associates for their help in depicting everything related to the creation of the Energia rocket.

Of course, what is written is the fruit of the author's perception of all the events taking place. But based on such memories, our descendants will be able to objectively perceive the past. I want to wish everyone who created the Energia-Buran complex not to be ashamed, but to speak about this past loudly, with dignity, showing that there is no greater satisfaction in the world than a good result of one's labor.